TEXTILES AND CLOTHING

McGOWAN AND WAITE

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TEXTILES AND CLOTHING

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PREFACE

This book has been written primarily to meet a need arising from the introduction of the study of textiles into the curriculum of the high school. The aim has been, therefore, to present the subject matter in a form sufficiently simple and interesting to be grasped readily by the high school student, without sacrificing essential facts. It has not seemed desirable to explain in detail the mechanism of the various machines used in modern textile industries, but rather to show the student that the fundamental principles of textile manufacture found in the simple machines of primitive times are unchanged in the highly developed and complicated machinery of to-day. Minor emphasis has been given to certain necessarily technical paragraphs by printing these in type of a smaller size than that used for the body of the text.

The authors emphasize the finished products and their relation to the household. Chapters have been introduced on the purchase, testing and economical use of textile material, with the hope of pointing the way to a concrete and practical application of the study of textiles. The woman of to-day can no longer afford to be untrained in this respect, and because of present economic conditions a definite obligation is laid upon her to understand the nature and real worth of clothing material and house furnishings, in order to buy with judgment and economy. The girl in high school has the opportunity to acquire this knowledge, which will function in her later life. We are gradually breaking away from the formal teaching of sewing as an isolated subject;

the relation of sewing to textiles and clothing is now emphasized from the economic and social side, as well as the practical.

It is hoped that the student may be encouraged to collect samples of representative materials and mount them either in a book or on filing cards prepared for the purpose. These samples should be classified and made of service by the addition of adequate data.

Although, as has been said, this book is designed principally to meet the needs of high school students, and through them, of homemakers, it may be of service to salespeople and teachers looking for reference material on textiles for their students.

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CHAPTER I

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If we look about us at the many kinds of fabrics used in our homes and for our clothing, or if we think of the infinite

variety of textile goods to which most of the space in our great department stores is given, we wonder where so much material comes from. Certainly these hundreds of products must mean many sources. How surprising it is to discover that, in the main, only four groups of living things — the cotton and flax, the sheep and the silkworm — supply the world yearly with its textile materials. What wonderful ingenuity man has shown in manufacturing from these few sources fabrics simple and elaborate, cheap and priceless — from six-cent cheesecloth to Gobelin tapestries and the rugs from Eastern looms! To trace the steps which convert textile fibers into fabrics is a study full of interest.

Source and composition of textile fibers. — Let us begin our study with the fibers, those tiny products of plant or animal life which are the basis of spun and woven material.

Vegetable fibers. — The principal fiber plants are cotton and flax. Cotton is the fiber of almost universal utility and enters into nine-tenths of the textile material of everyday use. Flax is the fiber of luxury. It is called linen when made into the thread or fabric.

Cotton and flax fibers are quite dissimilar in manner of growth and appearance. The cotton plant is a bushy shrub. Its seeds are inclosed in round pods or bolls. Each seed is covered with white or creamy hairs which grow from its outer coat. These are the cotton fibers. When the time comes for the bolls to burst open, the ripe cotton looks like masses of snow among the green leaves. Those fibers which, like cotton, grow from the skin covering of seeds are called seed hairs.

Flax is not a seed hair, but a part of the stem of the flax plant. Flax seeds are sown thickly, in order that the plants may grow too closely for branching. This gives a long, straight stem and fibers to correspond. A branching shrub, like cotton, would not yield long fibers. The flax fibers

are found just under the bark of the stem, and are as long as the height of the plant will allow.

The flax fiber is made up of a series of tiny cells, while the cotton fiber is composed of a single cell.

In composition, cotton is a pure form of cellulose, a substance composed of carbon, hydrogen and oxygen, belong-

From Brooks' Cotton, Courtesy American School of Correspondence

FIG. 1. — COTTON ON THE SEED.

ing to the group of compounds in which starches and wood are found. Flax is not naturally so pure. The stem of the flax plant contains woody tissue or lignocellulose, and the fiber must be separated from this by many processes. In its purified form, as line or linen, it is chemically the same as cotton.

Animal fibers. — The fleece of sheep and goats furnishes wool and hair fibers, and through the spinnerets of the silkworm is produced the long, lustrous silk filament. Since

these are of animal origin, they contain nitrogen, an element common to animal bodies, in addition to the elements found in cotton and linen. The presence of nitrogen gives one means of distinguishing animal fibers from vegetable. When wool and silk burn, part of the odor of burning is caused by the formation of ammonia, a nitrogenous compound. No ammonia, but an odor of burning wood, is noticed when cotton and linen burn.

Between wool and silk there is a further difference in composition. Wool contains a great deal of sulphur, and this also adds to its unpleasant odor when burned. Silk has no sulphur.

Wool and silk are entirely different in structure. The wool fiber is the most interesting of all because of its complicated structure. Silk, on the other hand, is called a structureless filament, being without cells or any separation of parts.

Hair fibers are similar to wool in structure. In the trade, fibers from sheep are called wool, and from goats, hair.

Classification. — A more complete classification of textile fibers, according to source, is as follows:

Vegetable fibers: Cotton, flax or linen, and the minor fibers jute, hemp, ramie, pineapple, kapok, coir.

Animal fibers: Wool and hair, silk.

Mineral and artificial fibers: Artificial silk, metallic threads, asbestos.

General characteristics. — Whatever the source, the fibers used for textile purposes must have length, strength and pliability sufficient to be spun into a continuous thread which can be woven. The fibers named above answer these requirements in differing degrees.

Cotton is the shortest fiber, running from $\frac{1}{2}$ inch or $\frac{3}{4}$ inch to 2 inches in length. There would be great difficulty in

spinning cotton of the shortest staple were it not for its pliability and a natural twist in the fiber, only visible under the microscope. The length of the flax fiber is determined by the height of the plant and the preparation; it may be from 12 inches to 36 inches. Wool lends itself well to the spinning process. The staple may be as short as 1 or 2 inches, but it averages from 4 to 10 inches, and much of it is naturally curly or crimpy. Hair fibers are straighter and in some cases less pliable, but may reach a length of 20 inches. Silk far outranks all other fibers in length. Its wonderful filament may be from 400 to 1300 yards long. Imagine a single cocoon unwinding to three times the length of the river span of the Brooklyn Bridge, or from six to eight times the height of the Washington Monument. Moreover, although the diameter of the silk filament averages less than that of the other fibers, in proportion to its size its strength is greatest of all.

When we compare the physical properties of the fibers, we must speak of averages. There are wide variations. A general tabulation like the following is useful, if this is kept in mind:

Length. — Silk fibers are the longest; then flax, wool, cotton in descending order of length.

Strength. — Silk is strongest in proportion to diameter; then flax, then cotton, and the weakest is wool.

Diameter. — Silk and cotton are uniformly finest in diameter. Flax and wool vary greatly.

Elasticity. — Wool is most elastic, followed by silk, cotton, linen in the order named.

Luster. — Artificial silk, silk, mercerized cotton, linen, wool, cotton.

Capacity for holding moisture. — Wool holds 12 per cent to 15 per cent of its weight under ordinary conditions, 30 per cent to 50 per cent in presence of excess moisture. Silk

10 per cent or 11 per cent in ordinary atmosphere, up to about 40 per cent under artificial conditions. Cotton and linen, 7 per cent to 12 per cent in ordinary conditions. Linen is more easily permeable by air and moisture than cotton, on account of its coarser pores, but loses its moisture much more rapidly.

Heat conductivity. — Linen is the best conductor of heat, by reason of the rapid evaporation of moisture from its surface. Cotton has 15 per cent to 30 per cent more heat protection than linen, in fabrics of equal weave and thickness. Silk and wool are both non-conductors; the latter retains body heat somewhat more than silk, because of the air-holding spaces in the fibers, and because of slower evaporation.

Cleanliness. — Silk and linen, by reason of their smooth surface, are the cleanest textiles. Investigators have shown that under equal conditions cotton collects about three times as much surface dirt as linen, with a corresponding increase in bacteria on garments worn next the skin. Wool collects the greatest amount of dust, dirt and bacteria, and is laundered with the most difficulty.

Microscopic appearance. — Every student of textiles should know the microscopic appearance of the principal fibers, and should use the microscope when possible as an aid in determining the kind and quality of the fibers in a fabric. Each fiber shows under the microscope structural markings, which in many cases are its best identification. This is especially true in determining the purity of linen weaves.

The high power of an ordinary compound microscope is essential. Under the low power we cannot appreciate the structure of a fine wool fiber, for example, which may be only 0.0005 inch in diameter, and have 4800 scales per inch of length.

In the following pages, emphasis is placed on the typical appearance only of the principal fibers. For more detailed study, the student is referred to the bibliography at the end of the book.

Cotton. — Seen under the microscope, the typical cotton fiber resembles a spirally twisted ribbon with thickened edges. The twist may not be continuous in one direction, nor of regular occurrence. The fiber is a single cell; the edges indicate the thickness of the cell wall. The flattened portion between the edges marks the position of the interior canal or lumen, which occupies about two-thirds the breadth of the fiber. Before the cotton reached maturity, this lumen was filled with nutriment for the cell, and the fiber was cylindrical. When fully ripe, the lumen contents dried or were absorbed, and the fiber shrank and collapsed into its flat, twisted form. It is generally conceded that the stronger and more frequent the twist, the better the quality of the fiber. Dead or unripe fibers do not show twist or lumen to any extent, but are straight, thin and transparent.

Fig. 2. — Cotton Fibers.

Mercerized cotton. — (See Chap. IV.) The process of mercerizing with strong caustic alkali changes the chemical and physical nature of the cotton fiber. As regards the latter, the fiber loses its cuticle and swells to a cylindrical form. The twist almost or wholly disappears. The body of the fiber is firm but translucent. All these changes greatly increase the luster, especially if the mercerizing is done under tension. It rarely happens that all the fibers of a given lot are equally mercerized; the presence of an occasional twist is conclusive that the fibers in question are

mercerized cotton, where there is any possibility, by reason of form and luster, of confusing them with silk. It is a safe rule, in using the microscope, to study any fiber throughout its entire length.

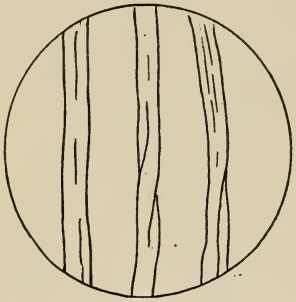

Fig. 3.— Mercerized Cotton.

Flax. — The purified flax or linen filament, as we ordinarily see it under the microscope, is straight, cylindrical, and has a lumen which shows as a narrow line. The end of the fiber is pointed. The distinguishing marks are frequent transverse lines or fissures, sometimes resembling the nodes or joints of the bamboo. There is much variation in the appearance and occurrence of these, and they may at first escape the eye of the beginner. The linen fiber requires more careful study than perhaps any other. Structurally, the fiber is composed of a series of cells of varying lengths, but averaging one inch.

Wool and hair. — These fibers are alike in their main structure, but differ in outward appearance. Three main divisions of the fiber may be made:

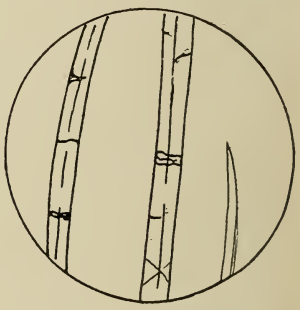

Fig. 4.— Flax Fibers.

1. Epidermal Scales. — The *epidermal scales*, horny and transparent, overlap like the scales of a fish. This is the most striking characteristic of the wool, but not the hair, fiber. In some fine wools, a single set of scales encircles the fiber like a series of cusps or funnels; in most varieties two or more scales make up the circumference. The lower ends of the scales are

fastened to the body of the fiber; the upper ends are often so loosely attached that they give a serrated or saw-toothed structure to the fiber edge. In the finer wools the scale edges are straight, in coarser wools they are often serrated or wavy. The presence of these overlapping scales affects the manufacture, dyeing and home treatment of woolen materials. For example, heat and moisture, acids or alkalies soften the walls of the fiber and cause the scales to open outward. If they are loosely attached, as in wool, they then interlock with those of contiguous fibers, and under the influence of fall in temperature, friction or pressure the interlocking becomes a permanent shrinking and felting. Short wools, such as merino, are crimpy and have a great number of serrations per inch, therefore they felt and shrink to a marked degree. Medium wools, such as crossbred, have more luster, fewer serrations, and less felting power. Long wools, *e.g.* Lincoln, and hair, such as mohair from the Angora goat, and alpaca from the alpaca goat, are straight, lustrous, and do not felt. This is because the scales are closely joined to the body of the fiber, so much so that they are usually invisible in hair fibers, a fact which differentiates these from wool.

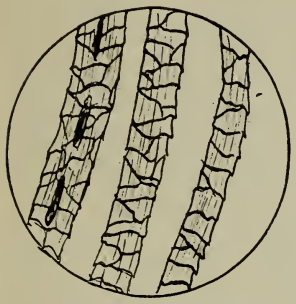

Fig. 5. — Wool Fibers.

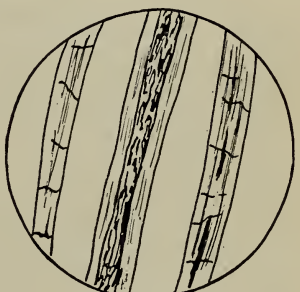

Fig. 6. — Hair Fibers.

2. Cortical Region. — The *cortical region* is the main fiber body. It is made up of spindle-shaped cells, which

give strength, elasticity and pliability to the fiber. Under the microscope this region is indicated by numbers of small, dark, longitudinal lines which can be seen through the epidermal scales.

3. Medulla. — The *medulla* is the central canal. Frequently it is not visible, especially in fine wools. In coarse wools and often in hair fibers it appears in varying aspects — as a narrow or a broad line, continuous or broken, sometimes containing irregular dark masses of pigment or other material.

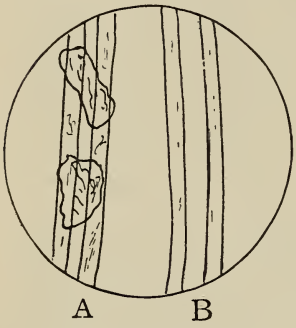

Fig. 7.—*A*, Raw Silk; *B*, Silk with Gum Removed.

Regenerated wool. — (See Chap. VI.) Wool of this kind, recovered from cast-off clothing or other sources, is called shoddy.

The microscope may show the presence of shoddy when it is characterized by broken or missing scales, split fibers, torn ends, and fibers of different sources and colors. Good grades of shoddy are not different in appearance and quality from some wool directly from the fleece.

Silk. — Raw silk, as it comes from the spinnerets of the silkworm, is in the form of a double filament, held together by a gummy substance called *sericin*. It is rough, dull and translucent. As we see it in most dress materials, it has been freed from the gum by scouring or boiling off, and is then a single, lustrous, transparent filament. It has no apparent structure, but looks smooth, fine and evenly cylindrical.

Wild or Tussah silk. — The name Tussah is generally applied to all varieties of this silk, which is produced by several kinds of silkworms differing from those which make the cultivated silk. Wild silk is always darker in color than

the cultivated. The microscope shows broad thick fibers, flattened in form, and characterized by distinct longitudinal striations. Often there are cross markings, caused by one filament pressing on another before the cocoon mass has hardened. The striations are held to indicate that the fiber is composed of minute filaments. The diameter of wild silk is frequently two or three times as great as that of the cultivated.

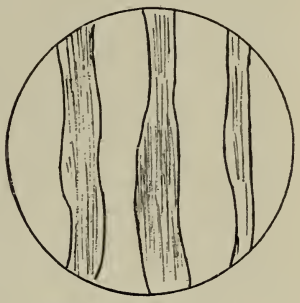

Fig. 8.—Wild Silk.

Artificial silk. — (See Chap. VII.) There are several varieties of these silks on the market, each characterized by slight microscopic differences. The viscose silk, most often seen in this country, shows a straight, exceedingly glossy filament, resembling a glass rod. The diameter is uniform throughout. There are as a rule lengthwise lines, straight and regular, covering the surface of the fiber, and occasionally small bubbles are seen.

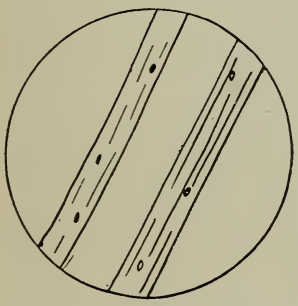

Fig. 9.—Artificial Silk.

Minor vegetable fibers. — Jute, hemp, ramie, pineapple fiber, coir and kapok are the principal fibers in this class.

Jute is a bast fiber from several species of a mallow, sometimes called Jew's mallow, native to India. It is also cultivated by the Chinese and Malays, and has been introduced into America along the Gulf coast. It is fine, lustrous, and soft, but not strong, especially when wet. When exposed to dampness it deteriorates rapidly. The fiber length averages 4 to 7 feet. Jute is used for bagging, burlaps, cheap twine, binding thread, and frequently in pile upholstery fabrics and as a backing for carpets and rugs.

Hemp. — There are thirty or more plants, similar in appearance and properties, and widely distributed geographically, that bear the name of hemp. Common hemp is a bast fiber from *Cannabis sativa.* It is grown extensively in Russia, Poland, Italy and the United States. Italian hemp is the finest grade in our markets. In growth and preparation hemp is similar to flax, and under the microscope they are not dissimilar. The fiber is lustrous, stronger than jute, and is not weakened by continued wetting. Coarse hempen fibers are used for sailcloth, canvas, ropes, hammocks and carpets, and in some upholstery material. Fine hemp may take the place of flax in all weaves except the finest linens. In the Philippines fine grades of Manila hemp are used for dress materials.

Ramie is a bast fiber obtained from the stingless nettle *Boehmeria tenacissima.* It grows in temperate climates, and in this respect is different from a similar fiber (China grass, from *Boehmeria nivea*) which thrives best in tropical or semi-tropical countries. There is practically no difference between the fibers in appearance or properties. Ramie is a strong fiber, as white as bleached cotton, and more lustrous than flax. It does not easily spin a fine yarn, although beautiful and delicate materials are made from it in China and India. It has been used with cotton, silk and wool in woven fabrics, and it produces a fine, close paper, used especially for bank notes. As a rule, ramie or China grass fabrics are characterized by harshness and inelasticity. The microscope shows fibers of great variation in diameter, from the fineness of silk to a breadth exceeding that of other fibers; the typical appearance is a broad, flat fiber with rough markings. In the United States the cultivation of ramie has not been commercially successful.

Pineapple fiber is a bast fiber from the leaves of the pineapple plant. It makes the fine Jusi and Piña cloth of the Philippines.

Coir is a fiber resembling horsehair in texture, prepared principally from the husk of the coconut. The color is cinnamon brown. It is strong and elastic, and finds a use in mattings, doormats, cordage and sailcloth.

Kapok, a variety of Bombax cotton, comes from the white cotton tree, which grows in tropical countries such as Ceylon, India and parts of South America and Africa. Dutch merchants trading with Java introduced kapok and gave it its name. The fiber is weak, short, silky, and of so light a specific gravity that it is sometimes used for life preservers. Mattresses and pillows are also stuffed with it, but it is not always satisfactory for this purpose, as the fibers

are brittle, and liable to break into fine bits that sift through the covering.

Fibers called vegetable silk, having a limited use because of their brittle nature, are akin to kapok. They are obtained from the seed pods of the milkweed, from the "silk-cotton" tree of the tropics and from the corkwood tree of the West Indies and Central America.

QUESTIONS

1. What are the main sources of textile material?
2. What constitutes a textile fiber?
3. Compare the two principal vegetable fibers as to manner of growth and physical properties.
4. Give the peculiar fitness of each to be used for spun and woven material.
5. State several reasons why linen is so valuable in Red Cross work.
6. What are the disadvantages of cotton toweling?
7. How do the animal fibers differ from the vegetable fibers in composition? How do wool and silk differ? Compare these two fibers as to their physical qualities.
8. By what distinct characteristics are cotton, linen, wool and silk recognized under the microscope?
9. Describe the structure of the wool fiber.
10. Why does wool shrink? What are the best and the worst possible ways of washing a sweater?
11. What is meant by shoddy? May a shoddy suit be of good quality?
12. Considering the heat conduction of wool and linen and their capacity for holding moisture, state the conditions under which each would be suitably used for under and for outer clothing.
13. Give the names and uses of the principal minor vegetable fibers.
14. What properties of the respective fibers would aid in distinguishing between China cloth and fabrics of pineapple fiber?

Questions and Problems for Further Study

1. Make a collection of yarns representing different fibers. Mount each on a card, adding a drawing of the fiber as seen through the microscope, and a short description of its properties.
2. Learn to recognize the principal fibers by eye and touch.

CHAPTER II

SPINNING AND WEAVING

A. Early Methods of Spinning and Weaving
- Early methods of spinning
  - Spindle and distaff
  - Processes involved in spinning
  - Carding
  - Use of spinning wheels
- Early methods of weaving
  - Primitive looms
  - Essential operations in weaving
  - Navajo loom
  - Zuñi heddle or loom
  - The hand loom

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  - The mule
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  - Cotton gin
  - Steam engine
- The textile industry in the United States
- The results of the factory system

C. Present Methods of Spinning and Weaving
- Modern spinning frames
  - Mule spinning
  - Ring spinning
- Modern weaving
  - Power loom
  - Jacquard loom

A. Early Methods of Spinning and Weaving

Early methods of spinning. — Spinning is the process by which fibers may be combined, drawn out and twisted to form a continuous thread. No one knows how the discovery was first made that certain fibers could be spun. Probably the earliest method was simply the twisting of the fiber between the thumb and the first finger as it was drawn out from a bunch of wool or cotton. As the thread was drawn out it was wound on a stone or stick and the process repeated until enough thread was spun. We know that for thousands of years B.C. and up to about 1500 A.D., all yarn or thread used was spun on a simple contrivance known as the spindle, and many different varieties of spindles have been found in many parts of the world among prehistoric relics.

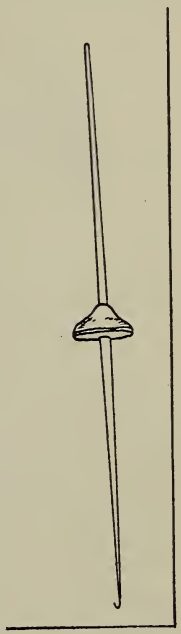


Fig. 10. — East Indian Spindle.

Spindle and distaff. — The early spindle was a straight stick from 10 to 12 inches long. A loose thread of wool was fastened to one end of this stick, and the stick was either whirled between the hip and the palm of the hand, if the spinner sat on the ground, or dropped at the side, if the worker was standing. During the whirling process the thread became twisted. After this twisting was done sufficiently the yarn was wound upon the stick and fastened at the end in a notch, and the process was repeated. Finally some one discovered that the spindle revolved more quickly when wound with yarn, as it became heavier, and a weight was therefore added at one end. This was called a *whorl;* it was a lump of clay,

or a stone, or a piece of wood. It also served to keep the yarn from slipping off the spindle. Spindles were made of wood, bone and metal, and many interesting ones may be seen in the museums.

The raw fiber to be spun was placed lightly around a stick which was held under the left arm or thrust into the belt. This was the *distaff*. In Germany it was called a *rock* and was held erect on a block while the spinner stood near by. In many parts of the continent one can still see peasants spinning with a spindle and distaff.

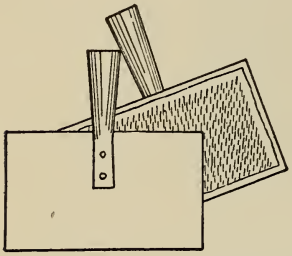


Fig. 11. — Hand Cards. Used for carding wool.

Processes involved in spinning. — It is well to understand clearly what the essential processes in spinning are:

(1) the drawing out of the fiber into a thread;

(2) the twisting of the thread to make it stronger;

(3) the winding up of the twisted thread on the spindle.

These underlying principles are the same ones applied later to the spinning wheel and at the present time to machine methods, although the method has varied greatly.

Carding. — The wool fibers were always carded before being spun, and carding is probably as ancient an art as spinning. In carding, the wool was untangled and formed into soft rolls by cards made of wood or leather into which wires were set. Two of these cards were used; the fibers were placed between them and with a card held in each hand they were so rubbed together that a soft roll of smooth wool resulted. (See Fig. 11.) This soft roll is now called a sliver.

Use of spinning wheels. — About the year 1500 a new method of spinning came into use in Europe. This was

the spinning wheel and was a great improvement over the spindle and distaff. Some one probably discovered that the spindle could be placed in a horizontal position and turned by a wheel, the result being a greater quantity of spun yarn and a saving of labor. The idea probably came

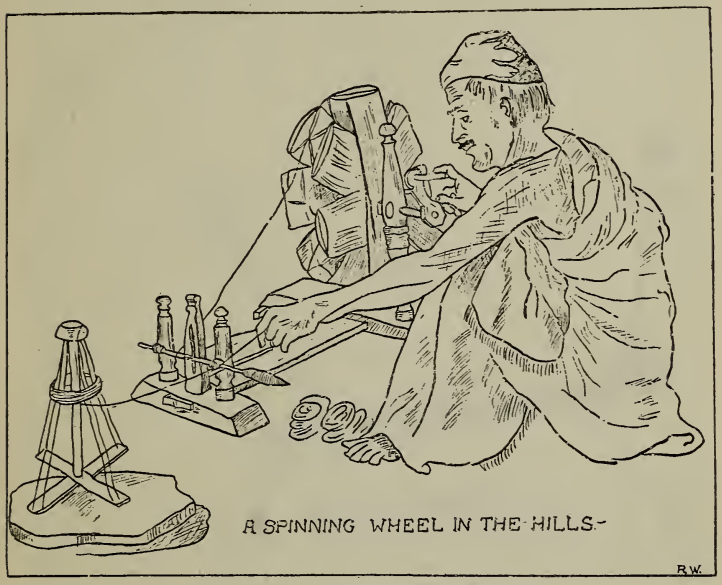


Fig. 12. — Old East Indian Wheel.

from India, as a teakwood wheel had been in use there for some time. This was a rude contrivance in which the spindle was attached to a wheel by means of a band and thus made to rotate. The spinner sat on the ground and supplied the spindle with raw material. A coarse yarn was spun in this way, but the spindle and distaff were used for the finer yarns.

1. Jersey or Wool Wheel. — The *Great, wool,* or *Jersey wheel,* for it is spoken of by all of these names, was one of

the first used. It varied in size in different countries, but the one used in the American colonies chiefly for spinning wool was a large wheel about 5 feet high. It consisted of a standard on three legs, at one end of which was a post

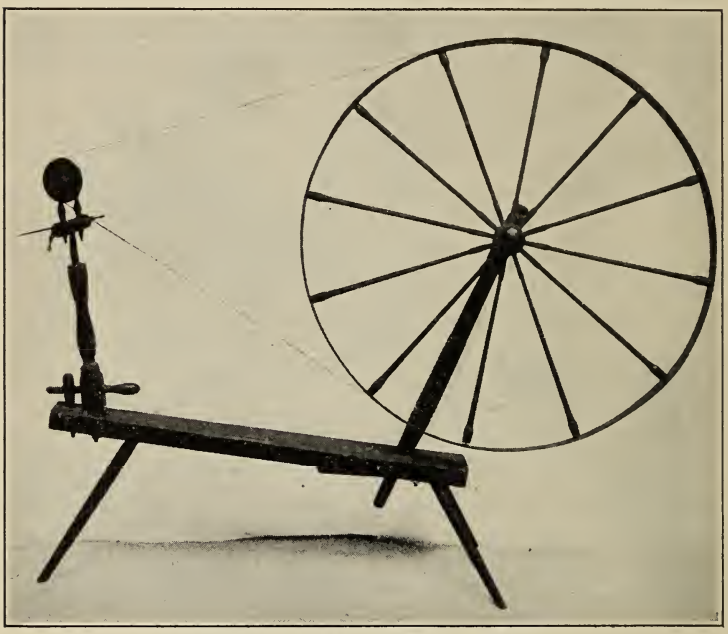


Fig. 13. — Jersey or Wool Wheel.
Used in early days in America.

holding a large wheel. At the other end of the standard two upright posts held the spindle in a horizontal position. To the spindle a small wheel was attached which was connected with the large wheel by a band or cord. (See Fig. 13.) When the large wheel was turned, the small wheel turned very rapidly and revolved the spindle. The wool or cotton was first carded by hand cards into slivers about

10 inches in length. The spinner stood beside the wheel with the sliver in her left hand and attached one end of it to the spindle. With her right hand she turned the wheel, thus causing the spindle to revolve, and at the same time with her left hand she drew the wool away from the spindle almost in a line with it. When the wool was fine enough and twisted sufficiently, the wheel was stopped and turned slowly in the opposite direction in order to bring the yarn into position on the spindle for winding. Then the wheel would be turned in the original direction, and the yarn held at right angles to the spindle and wound directly upon it. As will be seen, the motion was intermittent, the wheel revolving alternately in both directions. The spinner stood all the time, walking back and forth constantly. It has been said that a spinner on the big wheel sometimes walked twenty miles a day.

2. Saxony or Flax Wheel. — The *flax wheel* was a much more elaborate piece of mechanism than the wool wheel. It was much smaller and for that reason it is sometimes called the small wheel. The wheel turned by means of a treadle, and the spinner sat while spinning. The frame stood on three legs as did the large wheel, but it had a treadle at the bottom attached to the wheel by a rod. The wheel was at one end of the frame and at the other was a rod and a stick holding the flax. This stick was called the distaff. (See Fig. 14.) At the distaff end two upright bars held the steel spindle, which was pointed at one end and had an eye at the other. A wooden bobbin on which the yarn was wound was attached to the spindle and revolved with it. In the large wheel the yarn was wound directly on the spindle. A cord from the wheel turned a very small wheel on one side of the spindle and revolved the spindle and bobbin. An important addition to this wheel was the "flyer," a contrivance which revolved about the spindle and twisted

the yarn. This flyer was a U-shaped piece of wood with a series of hooks placed on each prong. The center of this was attached to the spindle and it revolved with the spindle. The hooks guided the yarn as it was wound on the bobbin.

Fig. 14. — Saxony or Flax Wheel.
Used in early days in America.

The small wheel was used mostly for spinning flax. Before spinning, the flax was prepared in such a manner as to untangle the fibers and then placed carefully on the distaff. The spinner sat beside the wheel and pressing the

treadle with her right foot caused the wheel to revolve in a continuous motion. Several threads of flax were brought down from the distaff, passed through the eye of the spindle over one of the hooks of the flyer, and attached to the bobbin.

FIG. 15. — WOMAN SPINNING WOOL ON SMALL WHEEL.
Chiefly used for flax.

With a smooth and even motion of the wheel the spinner guided the flax to the spindle, taking it from the distaff with her left hand and drawing and slightly twisting it with her right hand. The drawing, twisting and winding

went on continuously and not intermittently as with the big wheel. It took time and practice to become a good spinner, and beginners found great difficulty in revolving the wheel smoothly and drawing the fiber down evenly. The flax wheel produced seven times as much yarn as the spindle and distaff. This wheel was a great improvement over the wool wheel, as the continuous motion produced a larger quantity of yarn, and a harder twisted, stronger yarn than the intermittent motion of the wool wheel.

Comparison of Wool and Flax Wheel

Wool Wheel	*Flax Wheel*
Used for wool	Used for flax
No distaff	Distaff
No treadle	Treadle
Hand power	Foot power
No bobbin	Bobbin on spindle
Spinner stands	Spinner is seated
No flyer	Flyer
Motion intermittent	Motion continuous
Drawing, twisting and winding done by spinner	Drawing done by spinner, twisting by flyer, winding by bobbin
Product, softer yarn less twisted	Product, hard twisted stronger yarn

Early methods of weaving. — Weaving is one of the most ancient of arts as we find when studying the work of prehistoric peoples. It is the manufacture of a fabric by interlacing two sets of threads crossing each other at right angles. The warp threads are the lengthwise threads and are arranged first; the interlacing cross thread is called the woof thread or the filling; one woof thread across from side to side is called a "pick." A contrivance called a loom is used for weaving, and many interesting types of looms have

been used in the past. The first weaving was doubtless exceedingly simple and included mats, floor coverings and baskets made of grasses, reeds and rushes. A simple form of weaving was the wattling (Fig. 16), used for shelters by early people. A study of the exhibitions of primitive weaving in museums shows many interesting specimens of cedar bark weaving, mats woven with no looms of any description, belts woven on simple frames, and the interesting

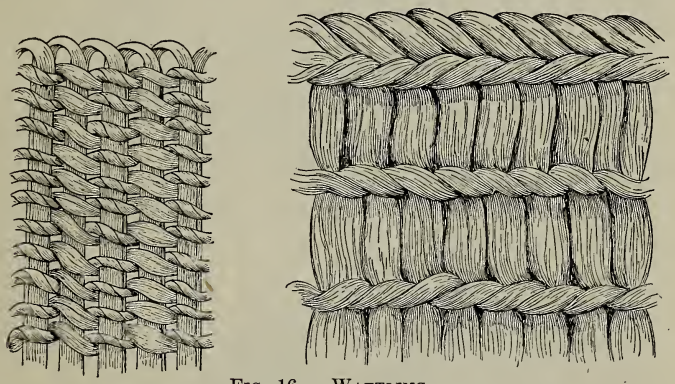


FIG. 16. — WATTLING.
One of the earliest forms of weaving.

Chilkat blanket in which the warp threads were tied to a top rod and weighted with stones at the bottom to hold them in place while the weaving was being done.

Primitive looms. — Two differing types of looms were the vertical or upright loom such as used by the Navajo Indians and the horizontal loom used by the Zuñi Indians. The chief difference in these was in the construction of the heddle.

The Heddle. — In all types of weaving the filling is passed in and out among the warp threads; at first this was probably done by the fingers, picking up first one thread and

then another, and pushing the woof thread through, much as darning is done to-day. Later it was found that an appliance separating these threads and raising at one time all of the warp threads needing to be raised, could be used. A woof thread wound on a twig or shuttle could be slipped across and much time and labor be saved. The appliance

Fig. 17. — Primitive Weaving.
Type of Zuñi Heddle.

used in separating these threads was called a *heddle;* the opening made when this heddle was raised was called a *shed* and the process of raising it was called *shedding.*

Essential operations in weaving. — In any style of weaving three essential operations are performed:

(1) The raising or lowering of the heddle to form the shed, called *shedding.*

(2) Throwing the shuttle carrying the woof thread across, called *picking,* and

(3) Pressing the woof thread up close to form a firm fabric; this is done either by the finger or by a separate device formerly called a batten; this operation is called *battening*.

FIG. 18. — PRIMITIVE WEAVING AND SPINNING. SPINDLE AND DISTAFF. LOOM WITH HEDDLE.

These operations are present to-day in all weaving processes; no matter how complicated the machine, the shedding, picking and battening always take place in the same order.

Navajo loom. — One of the simplest of looms is the one on which blankets and rugs are woven by the Navajo Indians of Arizona and New Mexico. The loom consists of a framework made of four poles inside of which at the top and bottom are attached two beams from which the warp is stretched. (See Fig. 19.) The shedding is done by a simple heddle made of wood and string, a straight rod is tied by string with a loop stitch to each alternate thread of the warp and when this rod is pulled up, every alternate thread is raised and the shed formed. A flat stick called a sword or batten is used to form the opposite shed and to batten up the woof thread. This woof thread is wound on a rude shuttle. The weaver usually begins to work from the bottom. When making a design she uses a simple wooden comb to push the filling close or " drive it home."

Zuñi heddle or loom. — The Zuñi Indians had a different type of heddle made of wood. They often wove narrow belts with no loom but the heddle frame and a shuttle, the latter used to beat the woof home. One end of the warp was tied to a cylinder-shaped rod and held between the feet; the other end was attached to the waist. (See Fig. 17.) The heddle frame was made of wood with alternate rows of upright slots and holes or eyes. Alternate warp threads were passed through the eyes and slots. To form the shed the heddle was raised; the threads passing through the holes of the heddle were pulled up while the ones passing through the slots remained stationary. To form the opposite shed the heddle was lowered. The same idea was used by the women in Colonial days in making tape. The operations of weaving were the same as on the Navajo loom.

The hand loom. — During the time spinning was done by the spinning wheels, the weaving was effected on a loom usually spoken of as the hand loom. This was the first

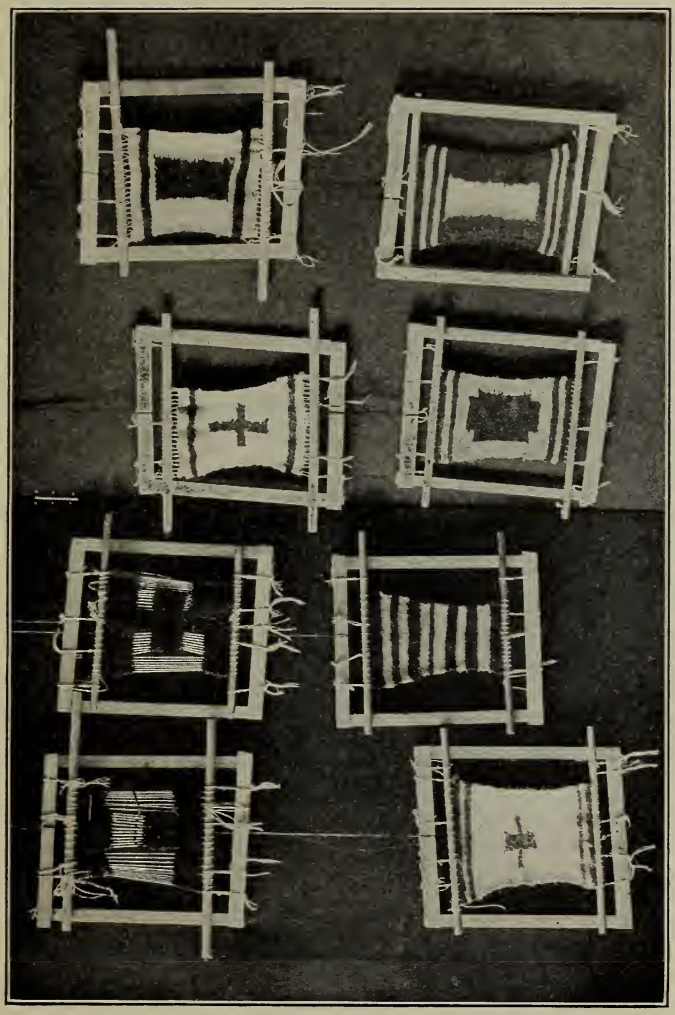


Fig. 19. — Loom Made by Elementary School Children. Navajo Method.

loom on which it was possible to weave a continuous fabric. This loom varied slightly in construction in different countries, but the one used in the early days of the American colonies is typical. Step by step devices had been added until the hand loom of Colonial times, sometimes called the Colonial loom, had become quite a complicated affair

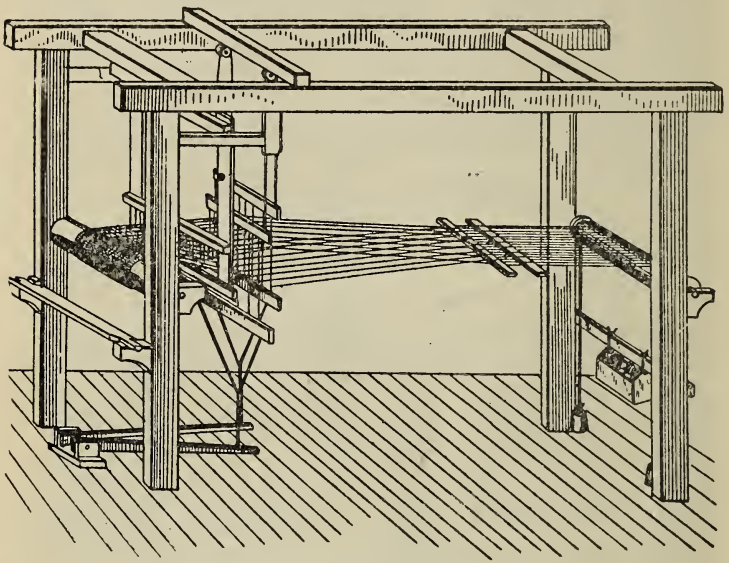


Fig. 20. — Hand Loom.
Showing warp threads, heddle, treadles and reed.

(Fig. 20). It had a stationary square framework containing a warp beam at one end on which the warp was wound, and a cloth beam at the other end which held the finished cloth. The warp threads passed from the warp beam through the harness, as the appliances for shedding were called. The harness was made up of a series of two or more heddles holding the warp threads which, in order to form the shed, were lowered by treadles at the bottom

of the loom. Each heddle was fastened to a treadle. Two heddles were always used for plain weaving; when a pattern was woven other heddles were used. Many of the looms had four heddles and six treadles — two heddles being tied together and attached to a treadle. (See pattern weaving, Chap. III.) The heddles in the Colonial loom were made on the principle of the Zuñi heddle, but while the Zuñi heddle worked up and down, and but one was needed, the heddles on the Colonial loom were lowered only, and in consequence two were always needed. To make the heddle, cords were tied in such a manner that an opening was left in the center, and these "healds," as they were called, were suspended on two sticks. For plain weaving a warp thread was put through a hole in the cord heald of the first heddle and then passed between the two healds of the second heddle; the second warp thread was passed between the two healds of the first heddle and into the hole of the heald of the second

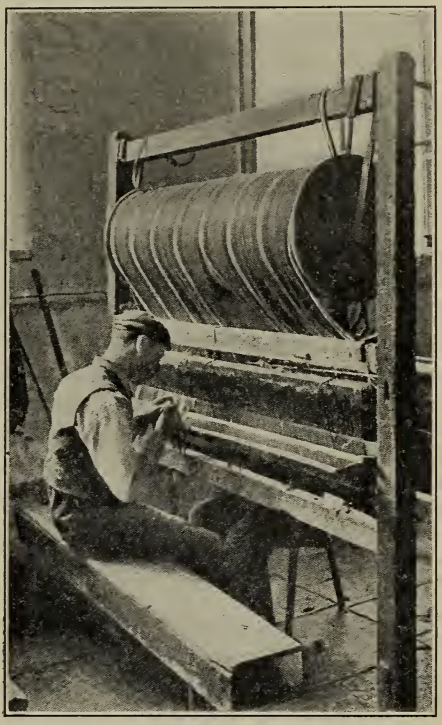


Fig. 21. — Drawing Thread through the Heddles and Reed. Present Day.

heddle. Thus, by pressing the treadle which pulled down the first heddle one shed was made, and pressing the treadle pulling down the second heddle the reverse shed was formed. The threading of the warp into the harness for pattern weaving was quite complicated. After passing through the heddles the warp threads were inserted in regular order in the reed, a contrivance made of wires used for battening the filling into place.

Method of Weaving. — The method of weaving was to press down the treadle, throw the shuttle through the shed and pound up the reed firmly against the cloth beam.

A temple or tenter hook was used on the finished cloth to keep the sides from drawing in. When a certain amount of cloth was woven, the warp threads were loosened, the cloth was wound up on the cloth beam, the warp unwound from the warp beam, the mechanism tightened firmly and the weaving continued. The shuttle was a pointed boat-shaped affair which held the bobbins. These were usually simple paper quills held in place by a wire.

B. The Industrial Revolution

Its place in history. — Up to the latter half of the eighteenth century there existed what may be called the domestic system of manufacture. Cotton and woolen goods which were sold in England or shipped to other countries from England were still carded, spun and woven in the scattered cottages of the rural districts of the west and north of England. Little change in method had been made, and the hand cards, spinning wheels and hand looms were the same as had been used for centuries. About the same time that the French Revolution was making political changes in France, a still more fundamental revolution was taking place in England, — a " sudden and silent " revolution in industry,

caused by a series of ingenious textile inventions which soon revolutionized every branch of industry. This is what we call the Industrial Revolution and means the change in methods of manufacturing and transporting merchandise brought about by the introduction of machines. Modern industry and the factory system may be said to date from this industrial revolution of the latter portion of the eighteenth century. Marvin in "The Living Past" calls it the "organization of industry by science."

The great inventions. — At the beginning of this transition from the domestic to the factory system we find four great inventions, — the Spinning Jenny, the Water Frame, the Mule and the Power Loom, — which played a very large part in shaping the world's social history. In the production of cloth by the loom and the spinning wheel, it was the spinning which occupied the most time. One weaver continuously at work could use the product of five or six spinning wheels, and the weavers were often obliged to stop work because of lack of yarn. This difficulty was increased by the invention in 1738 by John Kay of the fly shuttle, a contrivance which enabled a weaver, by pulling two cords placed in front of the loom, to drive the shuttle back and forth through the warp threads. Formerly, for weaving wide materials like broadcloth, two weavers were necessary in order to push the shuttle from side to side; but with the fly shuttle one weaver could do the work. This caused a still greater demand for yarn, as no corresponding improvement had been made in the process of spinning. In 1761 the Society for the Encouragement of Arts and Manufactures offered two prizes for improvements in the spinning wheel, and about 1767 James Hargreaves, a spinner and carder living in Blackburn, Lancashire, invented a new spinning machine known as the spinning jenny.

Spinning jenny. — As the story goes Hargreaves noticed that a large spinning wheel, accidentally overturned, continued whirling for some time with the spindle in a vertical position. He was struck with the idea that a number of spindles in a vertical position could be made to revolve by means of

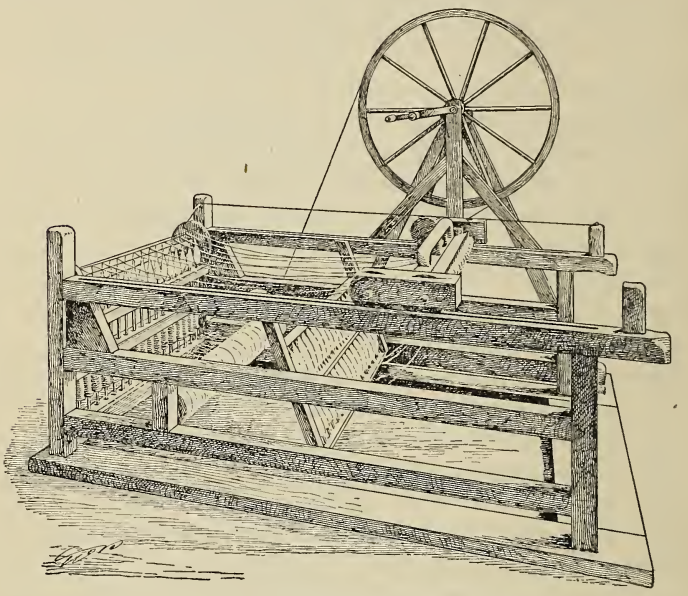


Fig. 22. — Hargreaves' Spinning Jenny.

a continuous band operated by one wheel only. From this idea he constructed a machine which would spin eight threads at one time and named it the spinning jenny. The principle was like that of the wool or Jersey wheel. The motion was intermittent, the drawing and twisting being done in one motion, and the winding in another. The jenny was a rectangular frame mounted on four legs, across one end of which were the spindles standing in a row and

revolved by a wheel. A frame in front of them moved back and forth, drawing and twisting the threads. By a little device the twisted threads were loosened from the top of the spindles, dropped down and wound about the base of the spindles (Fig. 22). The spinner turned the wheel by hand. The jenny greatly increased the amount of yarn produced, but the yarn was loosely twisted and not very satisfactory as warp thread. Hargreaves was able to get little advantage from his patent, although the machine was widely used, for the spinners, incensed at the invention and fearing it would take away their work, destroyed his machine and forced him to leave his home.

Arkwright's spinning machine. — About 1768, a barber named Richard Arkwright brought out a machine founded on the principle of the flax wheel. It had an upright frame with the spindle and flyer placed vertically as in the jenny, but the motion was continuous. It was first run by horse or mule power, later by water power, and is often spoken of as the "*water frame.*" It consisted essentially of two pairs of rollers placed a little distance apart. The rovings to be spun were fed between these rollers which, revolving at different degrees of speed, drew out the fiber to the spindles where it was twisted by the flyers and wound on bobbins. (See Fig. 23.) The introduction of this machine marked the beginning of successful roller drawing, now a part of all modern spinning.

It is generally thought that Arkwright appropriated some of his ideas from other people, but he was a shrewd hard-headed business man and accumulated a very large fortune. His work was so much appreciated that he was knighted in 1786. Because his machine ran by water power small factories soon sprang up, and he has been called the father of the factory system.

The yarn produced in the Arkwright frame was more

even in quality and harder twisted than that from the jenny, due to the continuous motion. It was a more

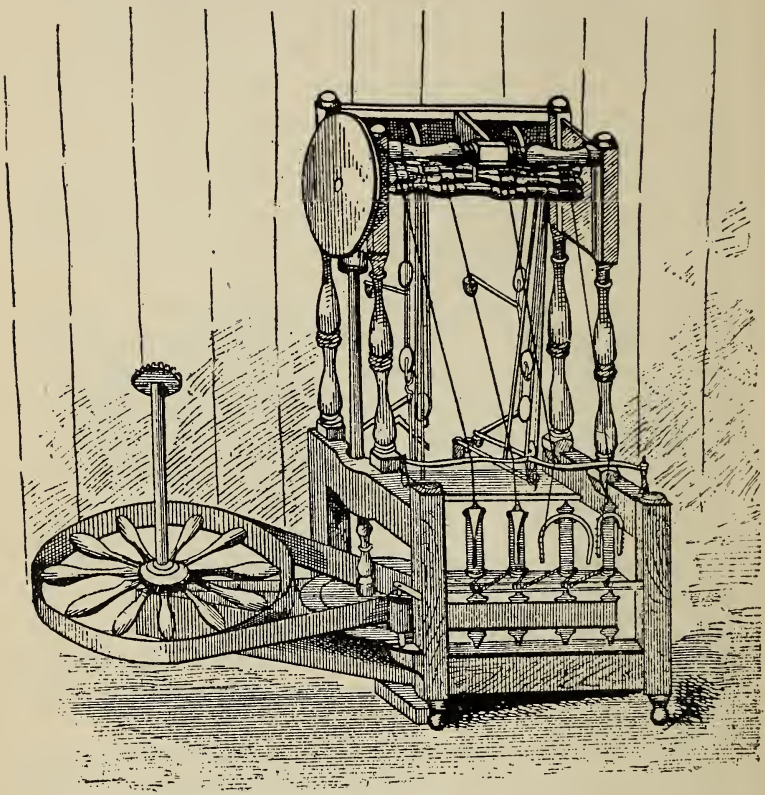


Fig. 23.—Arkwright's Spinning Machine Sometimes Called "Water Frame."

satisfactory yarn for warp, but though the machine spun thread suitable for many fabrics it could not twist it tightly enough to make fine threads.

The mule. — In 1779 Samuel Crompton remedied the

defect of loosely twisted thread by combining the most valuable points of the water frame and the spinning jenny, and called his invention the mule. Crompton was himself a textile worker and felt the need of a greater supply of yarn. He used the drawing rollers of the Arkwright machine, and in addition the movable frames and spindle of the Hargreaves jenny for still more drawing and for twisting and winding. The machine combined the drawing by rollers with the drawing by a movable carriage. It was more satisfactory and was used to a greater extent than either the jenny or the water frame and before the end of the eighteenth century 200 spindles could be operated on a single mule. This machine was the basis for one of the most useful spinning machines of the present day, the self-acting mule.

The power loom. — The spinning industry had increased to such proportions that it was now necessary for improvements in weaving to be made. From 1784 a clergyman, Dr. Edmund Cartwright, had been working on a power loom which by the beginning of the nineteenth century came into general use. In this loom all the operations made on a hand loom could be performed mechanically by revolving a single wheel.

Cotton gin. — While these inventions were being made in England, one was being worked out in America which was of vast importance in the manufacture of cotton goods. This was the cotton gin, for the removal of seeds from the cotton fiber, invented by Eli Whitney in 1794. This will be discussed at length in the chapter on cotton but is mentioned here because it played a large part in the great Industrial Revolution.

Steam engine. — The next stage in development was the application of steam power to these machines, and this was brought about through the perfection of the steam engine by James Watt. In 1781 Watt and Bolton began

to manufacture their engines, and in 1785 the first one was used for power in a cotton mill. After that time their use became more general, and by the beginning of the next century steam was rapidly superseding water power. It has been said that the steam engine alone has added to human power the equivalent of a thousand million men.

The textile industry in the United States. — During this time the New England colonies were making strenuous efforts to procure textile machines from England, but the exportation from England of all machinery, models or plans of machinery was forbidden by the British government. In 1790 Samuel Slater, who had been employed in an Arkwright factory, heard of the rewards offered in the United States and determined to venture his fortunes there. He memorized all the mechanical details of spinning and came to this country, where he built and operated a complete spinning mill at Pawtucket, Rhode Island. This mill was a success from the start, and cotton manufacture in the United States dates from this time. President Jackson called Slater the "father of American manufactures."

In 1814 Francis Lowell introduced the power loom. He brought the process of spinning and weaving under one roof in his factory at Waltham, Massachusetts, and this factory was called the first complete factory in the world. The factory system spread rapidly, and factory towns soon sprang up on the streams of New England and in the Middle States.

Results of the factory system. — The change from the domestic system of industry to the factory system made very decided changes in the conditions under which people lived and worked. Women in the homes began to give up their work at the spinning wheel when they found themselves unable to compete with the machine, and the factories

began to employ both men and women to run the power spinning machines. There was now a need for large bodies of laborers, working regular hours under one roof and under control of an employer. This brought capital into industry, and all the attendant problems involving both capital and labor.

It became necessary for the worker to live near the factory, and for this reason the cottage homes in rural districts were abandoned. New towns came into existence and rows of cheap houses were built near the mills.

This system made possible a minute division of labor, each worker concentrating his attention on one stage of the process instead of giving time and thought to the whole problem. There was an increased production of goods and a consequent reduction in the cost of the product. A continued demand for cheap yet pretentious fabrics has brought into the market a large supply of untrustworthy materials. Textile fabrics are no longer pure; the art of imitation has reached such a high degree of perfection that there is now a strong movement for pure textile laws to regulate adulteration.

One of the results of the new manufacturing conditions was the change in the place of woman in the home. She soon became a consumer rather than a producer. Many women were therefore obliged to go out into the working world, and an ever increasing number is found in the factory, office and department store. Woman is now a factor to be considered in the industrial life of every community. Dr. Sykes said the greatest by-product of the Industrial Revolution was the " transformation of the home, effecting changes in the life and work of women so momentous that they amount to a revolution."

C. Present Methods of Spinning and Weaving

Modern spinning frames. — The difference between old and new methods of spinning and weaving is not in the principles employed, as present methods follow closely the inventions of Hargreaves, Arkwright and Crompton;

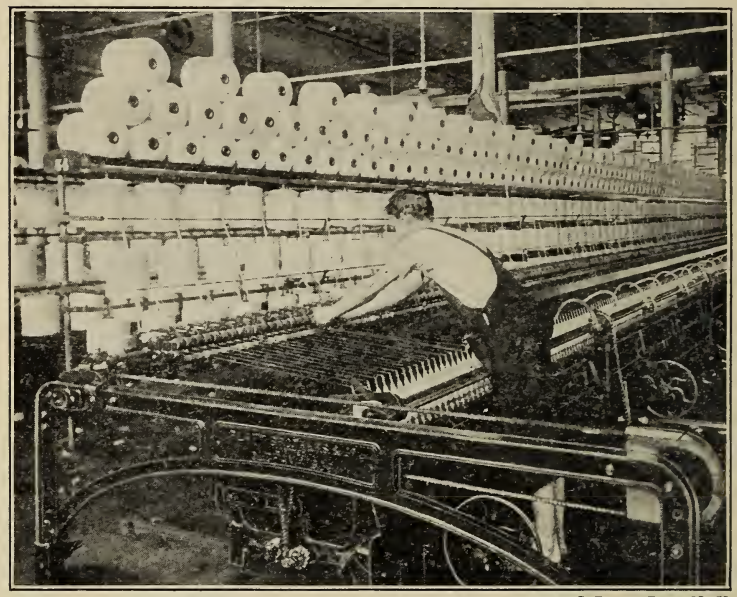


Fig. 24. — Mule Spinning.
Showing spindles and movable carriage on track.

the difference is in the mechanism used to take the place of the hand and in the remarkable increase of product. A worker now can spin 1200 times as much in a day as was spun with the old spinning wheel. There are two general types of spinning machines in use, the mule frame and the ring frame. Both have developed from the two hand wheels;

mule spinning is based on the wool wheel and the spinning jenny, and ring spinning is an outgrowth of the flax wheel and the water frame.

Mule spinning. — The mule has rollers which draw out the fiber; upright spindles on a movable carriage which travels back and forth on a track about 5 feet in length; and "faller wires" which guide the thread in winding. The action is intermittent as in the great wheel. The mule is a complicated machine and requires a skilled attendant. Men are usually employed for this work. A woolen mule has from 400 to 600 spindles while a cotton mule may have from 600 to 1200. A soft elastic yarn of excellent quality is produced that is satisfactory for cotton hosiery, underwear, and all woolen goods.

Ring spinning. — The ring frame is an American invention dating back to 1828. Following the Arkwright water frame came a series of inventions to improve the spindles. The "ring" is a contrivance placed on the spindle and has to a great extent taken the place of the flyer. The machine is very complicated and a detailed description will not be given here. The spinning frame has drawing rollers and upright spindles with bobbins. The drawing, twisting and winding are done separately but continuously. The flyer of the old spinning frame has been placed on a different machine called the "bobbin and fly frame" and this machine is now used to prepare the cotton for spinning.

Modern weaving. — *Power loom.* — In 1830 Roberts invented a power loom which was an improvement on the Cartwright loom. In the looms used to-day, all the old operations are present but they are done by machinery. There are also various devices for letting out warp, winding up cloth, moving the tenter hook, changing bobbins and mending broken threads. Everything is automatic, and the weaver of to-day has little to do but watch his machine. (See Fig. 25.) One man can tend from four to six looms which, according to the kind of material woven, will make from 200 to 300 picks a minute. Looms vary according to the materials woven upon them. The terms ribbon looms,

gingham looms, plush looms and carpet looms are illustrations of adaptations to needs. The fineness of cloth is expressed by the number of picks and ends to a square inch. (See Chap. III.)

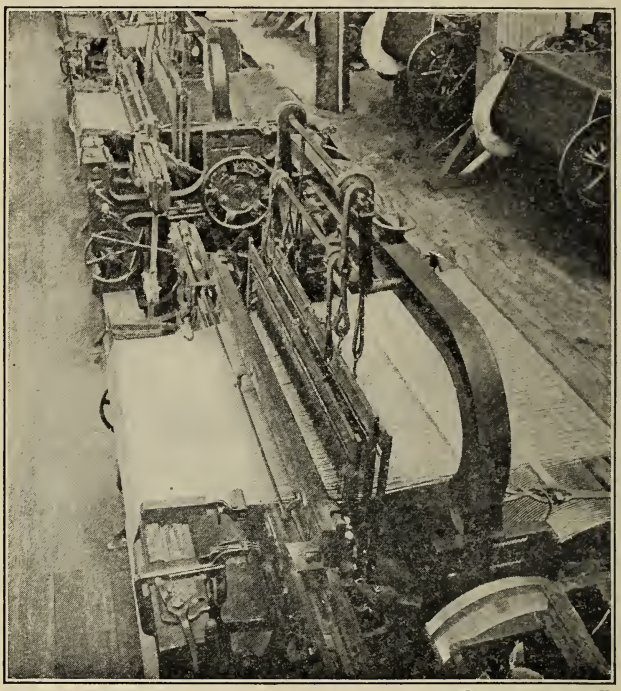


FIG. 25. — MODERN LOOM.

Showing cloth in process of construction, method of passing through harness.

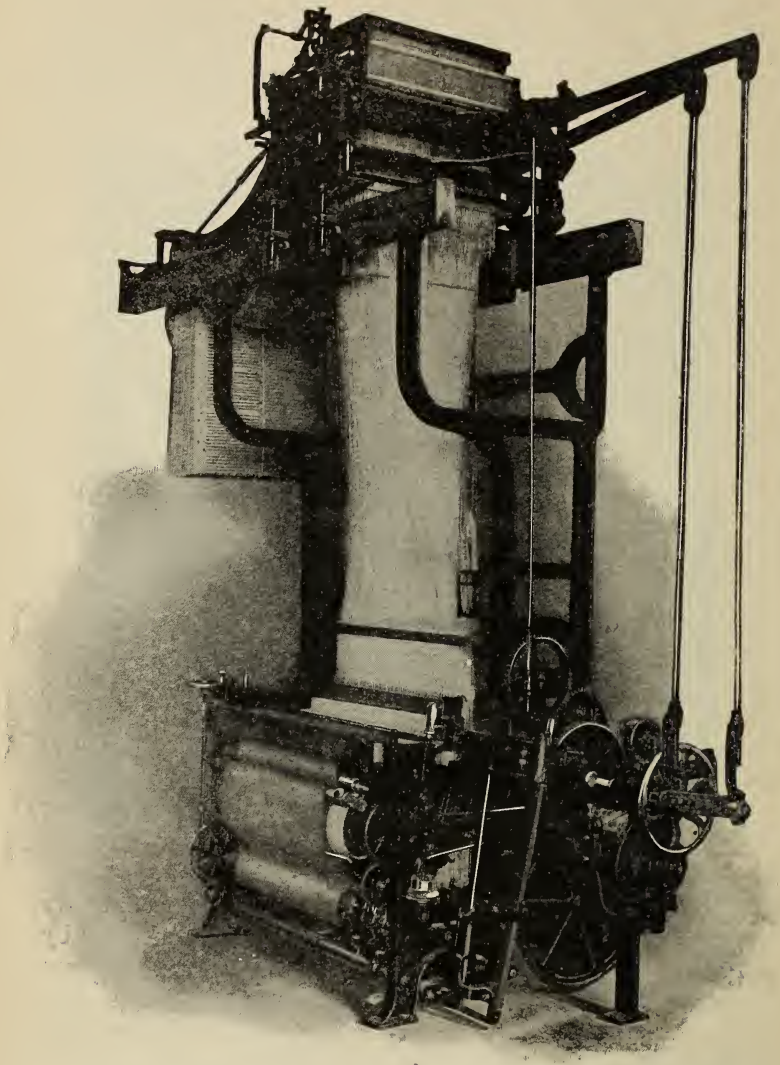
All power looms without special appliances are limited as to pattern because the pattern is dependent on the number of harnesses, and only a comparatively small number can be used on one loom.

Jacquard loom. — The Jacquard loom is the one generally

used for weaving pattern goods. It was invented by a Frenchman, Joseph Marie Jacquard of Lyons, France, in response to a demand for a method of weaving more elaborate designs in silk and linen materials. The invention

FIG. 26. — MODERN WEAVING ROOM.

consisted in a new method of shedding, operated from above the harness. In the old looms the harness was operated by the treadles. In the Jacquard loom the warp threads are operated separately instead of in groups, so that a very large number of sheds can be opened and elaborate patterns made. The expense of operating a Jacquard loom is



Courtesy of Crompton and Knowles Loom Works.

FIG. 27. — JACQUARD LOOM.

very great, owing to the cost of making the design, perforating the cards which control the pattern and setting up the warp. For that reason patterns are duplicated many times, and some of the old damask designs have been repeated for many years.

The News a Century Ago

[FROM THE FILES OF THE EVENING POST OF 1814]

[*From the Richmond Daily Compiler*]

The Loom. — This admirable piece of mechanism, at once the triumph of American ingenuity and one of the surest pillars of her independence, remains still at the Capitol for the inspection and gratification of the curious. A number of ladies and gentlemen visited it yesterday, and all were surprised and delighted at the simplicity of its construction and movement, the rapidity of its execution, and the excellence of the fabrick which it produces. *That* now in the loom, is a piece of cotton shirting worth about 75 cents per yard, and it is truly interesting to observe how visibly to the eye the operation of the machine causes it to grow into existence. We are told that a young girl of ordinary capacity may in two or three days learn to weave at the rate of fifteen yards a day; and a more skilful artist, twenty-five to thirty yards. The shuttle, it is said, may be thrown with the astonishing celerity of 150 to 200 times in a minute; and the manual power requisite to produce this *lightning* movement is not greater or more laborious, apparently, than that which would be necessary for the grinding of coffee and the churning of butter. The economical and the curious, the industrious and the fashionable, the money-making and money saving in the domestic or manufacturing line — and in short all the citizens of Richmond, are invited to go and examine this chef d'œuvre of the useful arts.

[Aug. 17, 1814.]

QUESTIONS

1. What were the processes of spinning a thousand years ago and with what contrivance was spinning done?
2. How was weaving carried on a thousand years ago?
3. What were the methods by which spinning and weaving

were carried on in England in the early part of the eighteenth century?

4. What effect did the invention of Kay's fly shuttle have upon the amount of material produced and the demand for yarn?

5. With improvements in the methods of spinning would there be a reaction upon weaving, and cause any change there? What would be the result?

6. Would the taking of spinning and weaving out of the home and putting it into factories have an influence on the work of women?

7. What was the Industrial Revolution?

8. What were the important inventions of the period known as the Industrial Revolution?

9. What effect has this Industrial Revolution had upon women's work to-day?

10. How did the textile industry have its beginning in the United States?

11. What were the differences between the wool and the flax wheel?

12. What are the modern methods of spinning?

13. How important an invention was the Jacquard loom?

14. Compare the output of a loom of to-day with that of one a hundred years ago.

Questions and Problems for Further Study

1. Trace the use of the "intermittent motion" of the wool wheel through to the mule spinning machinery of to-day.

2. To what extent is the Jacquard loom used in this country in the manufacture of materials?

3. Make a study of the development of the textile industry in America from 1740 to 1840.

4. In what parts of the United States do we find to-day a revival of the hand industries of spinning and weaving?

5. How valuable do you consider hand weaving as an occupation for disabled soldiers?

CHAPTER III

STRUCTURE OF FABRICS

A. Woven Fabrics

Structural design
- Making of patterns
- Classification of weaves

Surface design
- Design added in the finish
- Color applied as surface design
  - Hand colored
  - Machine method

B. Knitted Fabrics

History of knitting
Knitting machinery
Growth of knitting industry
Knitted products

Practically all textile fabrics used are either woven or knitted. In woven material, as we have seen in the previous chapter, there are two sets of threads, crossing each other at right angles (see Fig. 28); the threads running the length of the cloth are the warp threads, those running the other way are the woof, weft or filling threads. One woof thread from selvage to selvage is called a pick. In the knitted fabric only one thread or set of threads is used, and each succeeding line of threads is looped into the one before it. (See Fig. 29.) Knitting as a factory industry is comparatively recent, but hand knitting has long been a home industry.

A. Woven Fabrics

There are two distinct ways in which designs are shown in woven fabrics; the pattern is woven directly into the material through some weaving mechanism as in structural design, or it is applied to the surface of the finished fabric as in a surface pattern. Both of these are carried out in various ways.

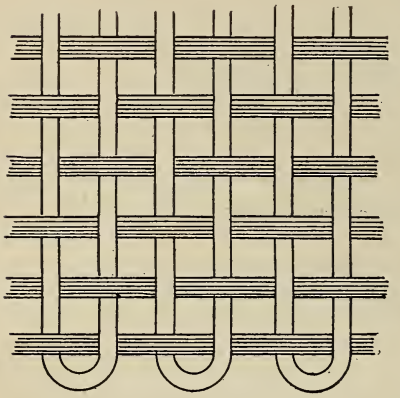


Fig. 28. — Structure of Woven Fabric

Dark line, warp thread; white line, woof. Plain weave.

Structural design. — There are a number of variations of weave which are followed in structural design. Sometimes the variation is made by using a different colored warp and woof, usually with a plain weave. Such an effect is usually spoken of as changeable. Chambray and seersucker gingham are examples of this changeable effect.

A stripe is made either warpwise with the warp of various colors and the filling solid; or fillingwise with the warp a solid color and the filling of various colors.

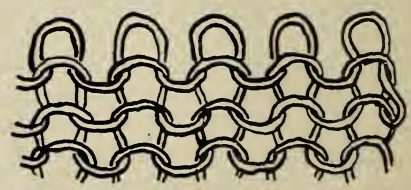


Fig. 29. — Structure of Knitted Fabric.

A *check* is made when both warp and filling are striped uniformly with differing colors. In a *plaid* both warp and filling are striped irregularly.

By giving some yarns a different twist, a different appearance is given the fabric; as in Georgette crêpe and crêpe de chine.

Making of patterns. — The designing of fabrics is an art requiring a high degree of skill, judgment and knowledge on the part of the designer. There are many different types of looms, and many varieties of fabrics are produced from the textile fibers. Designs for woven fabrics are first worked out on squared paper blocked off by lines into squares of eight each way. (See Fig. 30.) The squares running lengthwise represent the warp and the ones running crosswise the woof or pick. The way in which the warp threads cross the woof makes the design. Shaded blocks are generally used to show warp threads and white blocks to show that the filling or woof is on top with the warp threads underneath. If samples of cloth of different weaves are collected and threads raveled out a little and the samples then examined very carefully under a pick glass, the manner in which the threads cross each other and form a pattern may be observed.

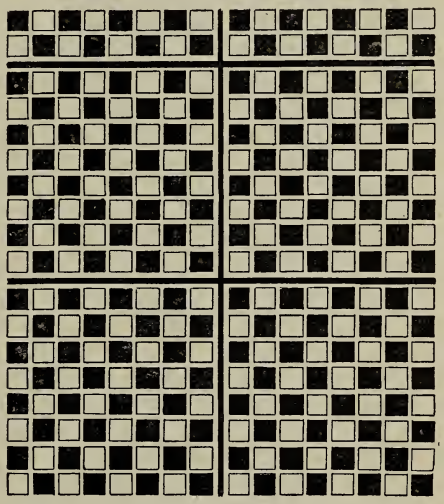


Fig. 30. — Pattern Used in Designing Fabrics.

Dark blocks show warp threads; white show filling on top.

Classification of weaves. — 1. Plain weave. — The simplest weave and one in which many materials are woven is the *plain weave.* The woof thread passes through the warp in regular order, alternately going under and over a thread until the edge or selvage is reached, when it turns and goes back, passing under the thread it passed over in the previous pick. This makes a strong, firm cloth but less close and heavy than some fabrics, as the threads do not lie so close together. (See Fig. 31.)

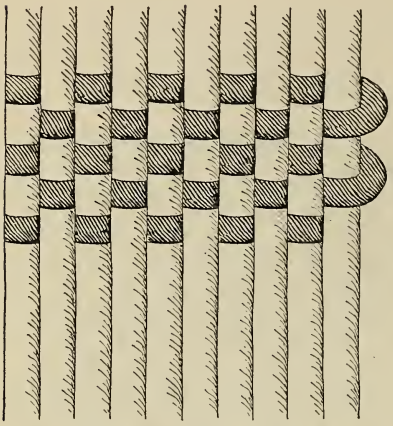


Fig. 31. — Plain Weave.

Examples of plain weave in different fibers are:

Cotton — muslin, nainsook, sheeting.

Flax — dress linen, handkerchief linen, canvas.

Wool — flannel, voile, challie.

Silk — taffeta, China silk, Habutai silk.

Variations of this plain weave are the *rib* weave and the *basket* weave. A corded or ribbed effect is secured by varying the size of the threads of either the warp or the filling. There are also variations in the rib weave, such as mixed and irregular ribs. Some of the materials showing rib weave are poplin, Bedford cord, pique, grosgrain, repp, etc.

In the basket weave, two or more warp threads are crossed by two or more filling threads, or there may be a larger number of threads one way than another. This makes an attractive fabric but one that does not wear particularly well. Examples are monk's cloth used for upholstery and

curtains, Java canvas used for embroidery, and Panama cloth.

2. Twill weave. — In the *twill weave* the warp crosses over and under the woof in a regular variation, sometimes over one thread and under two threads, or over one and under three, the filling moving forward in a regular progression of one. (See Fig. 32.) This gives a diagonal effect to the cloth. There are many variations of the twill weave and many different fabrics are manufactured. Besides the simple twill there are the break, the skip, the corkscrew and the figure twill. Twills are firmer and stronger than plain weaves and are used nearly as much.

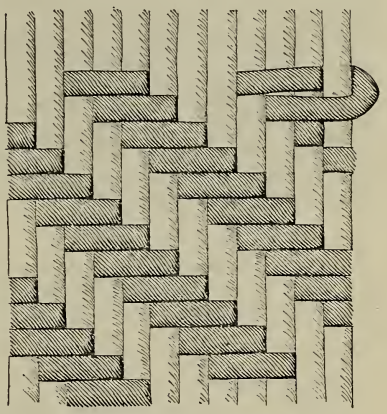


Fig. 32. — Twill Weave.

Examples are:

Cotton — galatea, denim, khaki.

Flax — twill toweling, linen ticking.

Wool — serge, cashmere, gabardine.

Silk — foulard, silk serge.

3. Satin weave. — Satin or sateen is a fabric with a smooth lustrous face, the luster coming partly from the character of the raw material, partly from the interlacing of the threads, and partly from reflected light. *Satin weave* is somewhat like twill, but no trace of twill may be seen on the cloth. A filling thread is made to pass under one and over from six to twelve threads. (See Fig. 33.) The interlacing is done at irregular intervals, thus preventing a twill

from showing. The terms satin and sateen are both used for this weave. If the filling is brought to the surface it is called sateen, and if the warp is on the surface it is called satin weave. A thread which passes over several threads is called a float. Cotton is frequently mixed with silk in a satin weave, as when a silk filling covers a cotton warp. Skinner's satin is an example of this. Recently many silk materials have been given what is known as a satin finish — examples are messaline, satin charmeuse, and crêpe meteor.

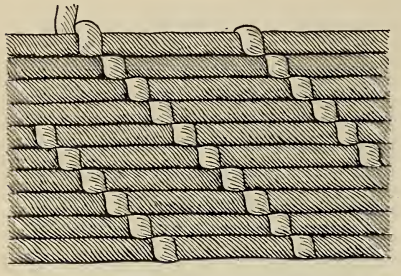


Fig. 33. — Satin Weave.

Examples are:

Cotton — sateen, linings, surf cloth.

Flax — damask to some extent.

Wool — Venetian cloth, prunella.

Silk — satin, peau de soie, peau de cygne.

4. Figure weaving. — These weaves are produced mainly on the Jacquard loom (see Chap. II), and include all materials made up of elaborate patterns. The warp and woof threads are intersected in a varying number up and down, with the result that many varieties of patterns may be worked out. (See Fig. 34.) On the old Colonial looms the patterns were made by the arrangement of the warp threads through the harness. By using four heddles and six treadles, and tying heddles together in pairs, a number of different sheds could be made and the elaborate patterns which we often find in the old handwoven coverlids were woven. Now the Jacquard looms weave more intricate patterns, but the results are not more beautiful. The background of the

figure weave in damask is generally a plain or a satin weave. Diaper is the weaving of a small pattern like bird's-eye or huck. In damask the pattern is reversible, appearing equally on both sides with no definite right or wrong; but brocades are woven with the pattern on the face only, the figure appearing but faintly on the wrong side. Tapestry is also a form of figure weave.

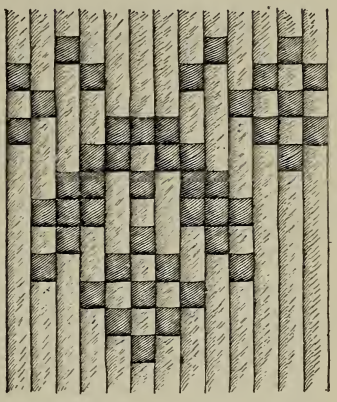


Fig. 34. — Pattern or Figure Weave.

Examples are:

Cotton — madras, cotton damask, huck toweling.

Flax — damask, bird's-eye toweling.

Wool — granite cloth, novelty dress goods, upholstery materials.

Silk — brocades, broché.

5. Pile Weave. — A weave in which some of the threads are drawn up to the surface and either left as loops, as in Turkish toweling, or cut off evenly as in velvet or plush, to form a solid nap, is called a *pile weave.* The pile may be formed in the warp and may be either cut or uncut. There are two sets of warp to one of filling. At regular intervals one set of warp passes over an inserted wire which pulls up the threads and forms loops. If the pile is to be cut a knife is at one end of the wire which cuts the loops as the wire is withdrawn. The better grades of Turkish toweling, velvets, and plushes are woven in this way. (See Fig. 36.)

Where the pile is formed by the filling, two sets of filling threads are used and one of warp. There are no wires

in this method, the filling being simply formed into regular loops and cut later along the length. Many cotton velvets and velveteens are made in this way. Plushes are sometimes woven as double cloth but the pile threads pass from one set of warp to the other and are later cut half way between the two. The result is two distinct materials. In recent years many imitations of furs, such as seal plush, Persian lamb, broadtail, have been made with this weave. Carpets are also woven with pile weave.

Examples of pile weave:

Cotton — corduroy, Turkish toweling, velveteen.

Wool — wool plush, velour, carpets.

Silk — velvet, plush, chiffon velvet.

6. Double-cloth Weave. — When two cloths are made at one time the process is called *double-cloth weaving*. This is done for different reasons: sometimes it is desired to use a cheaper material for the cloth forming the back, or a two-faced material is needed with a different pattern on each side. Sometimes it is used in making tubular pillow cases. In many cases a double cloth is necessary for heavy overcoatings, golf, or polo cloth. Two sets of warp and filling are used which are interlaced at definite intervals, thus fastening them together and making a solid fabric. A sample of this material when pulled apart shows two distinct fabrics.

Examples of double cloth:

Cotton — pillow tubing, silence cloths, blankets for bathrobes.

Wool — polo cloth, steamer rugs, cloakings.

Silk — curtain materials, upholstery fabrics.

7. Gauze Weave. — In a *gauze weave* the warp threads do not run parallel but are twisted and crossed from left to right and from right to left, two warp threads being entwined alternately between every two filling threads. (See Fig. 35.) This produces an openwork effect which is

light and sheer, and if well woven, wears very well. Marquisette and grenadine are examples of this.

When gauze weaving is done in combination with plain weaving, the result is called a Leno weave. Many cotton dress materials and window curtains are done in this way.

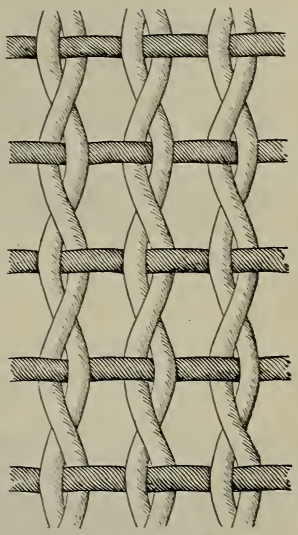


Fig. 35. — Gauze Weave.

8. Lappet Weave. — *Lappet weaving* is a form of embroidery used in working small designs on the surface of a fabric. Elaborate figures cannot be made, but dots and narrow figures like stripes may be worked. Needles placed in a sliding frame stitch in the figures. Sometimes long threads are left on the wrong side and must be cut off. This does not produce a very satisfactory fabric, as the ends are apt to pull out.

Surface design. — When a decoration is applied to a fabric after the fabric is woven we get what is known as surface design. This is applied in several ways; sometimes the fabric undergoes a finishing process which leaves a pattern, or it is decorated by applying color in different ways.

Design added in the finish. — 1. Moiré or watered effects are made at the time of finishing the cloth. The material is placed under hot rollers engraved with a moiré design. These rollers are so arranged as to press some of the threads down flat while leaving the other threads round. The material is usually folded lengthwise and a paper is inserted. The material is then dampened and sent through the calen-

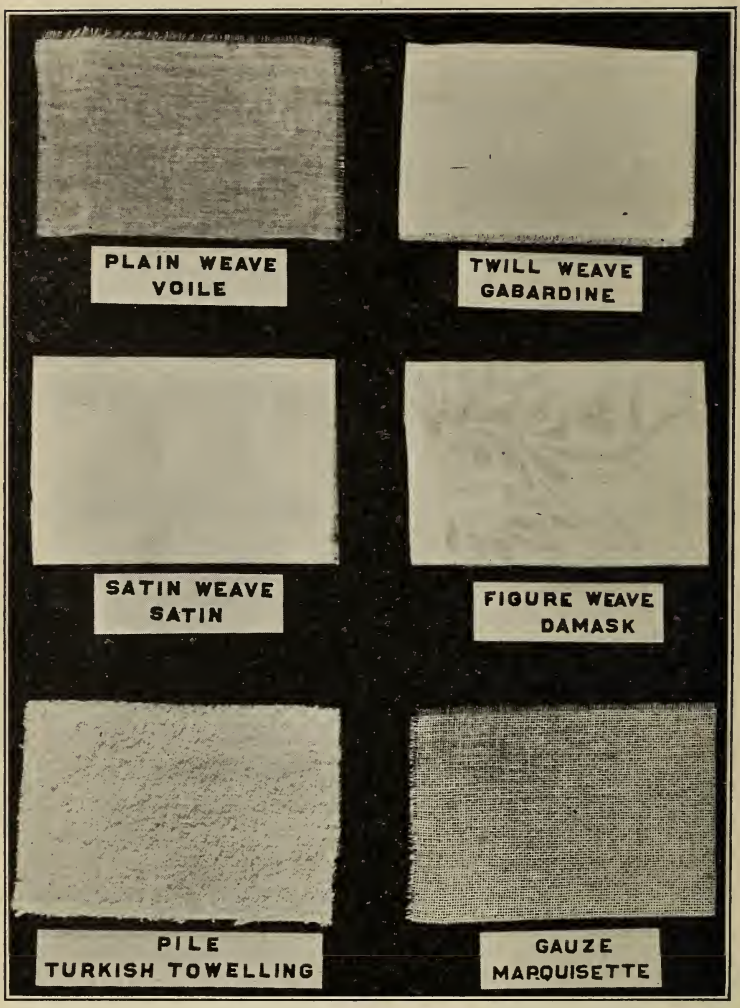


FIG. 36. — SAMPLES OF FABRICS ILLUSTRATING DIFFERENT WEAVES.

der, as the pressing machine is called. But little dressing is used. This effect is seen in percaline, moreen, and moiré velour.

2. Embossing is sometimes done on soft fabrics by using engraved rollers on the calender, the pattern being reproduced upon the cloth. Design is made on pile fabrics in the same way. Some of the crinkled crêpes are embossed.

Color applied as surface design. — Colored design may be put on plain woven fabrics either by hand or machine methods. Many of the old methods of hand color treatment have been revived during recent years and some beautiful fabrics have been produced.

1. Hand Colored. — In *tied and dyed work* certain parts of the fabric which are arranged to form a pattern are tied with string. The fabric is then dyed, and as the spots covered with string do not take the dye, a pattern results. Materials are sometimes dyed several times with different portions tied each time.

In *Batik work*, which originated in Java, all the material which is not to take the dye is brushed over with wax. After dyeing, the wax may be removed and again applied to other parts and the fabric dyed a second or third time. This process, with "tied and dyed" work, are forms of "resist dyeing."

In *block printing* a block is made on which the pattern is cut. The design is applied to the material by stamping it with the block which has been brushed with color. Sometimes several blocks are used.

In *stenciling*, a pattern is cut out of heavy paper or metal. This stencil, as it is called, is placed on the material and the color painted through the open spaces in the pattern.

Design is also applied by *hand embroidery*.

2. Machine Method. — The *machine method* of applying colored design to fabric is usually called roller, cylinder

or machine printing. This process is discussed in the chapter on Cotton under the topic, Printing of Cotton. The cloth is run through a printing machine supplied with a separate roller for each color to be printed on the fabric. Sometimes the cloth is printed with chemicals before dyeing and the printed parts remain unchanged by the dye. This is called "resist dyeing." In "discharge dyeing" the material is first dyed and the color is taken out in certain places by chemicals, leaving the design either white or of a different color.

The printing process is used extensively in the coloring of cotton goods, and calicoes, percales, chintz, cretonnes, etc. are colored in this way. Silks are sometimes printed, and challie, a wool fabric, is also printed.

B. Knitted Fabrics

History of knitting. — Knitting is the looping of a single thread into a fabric by the use of wires or needles. This produces an elastic material which is easily distinguished from a woven fabric and which is especially valuable for undergarments. The art of knitting is of very modern origin as compared with that of weaving. Comparatively nothing is read of it until the beginning of the fifteenth century. In 1488 knitted caps are mentioned in Parliament proceedings in England, and Henry VIII is known to have worn Spanish silk stockings. The implements used for hand knitting are very simple, being merely two pins or needles. The manufacturing industry, however, calls for very complex and ingenious machinery.

Knitting machinery. — The first stocking machine was probably invented by the Rev. William Lee in Nottingham, England, in 1589, but its use was discouraged because of the fear that many people would thereby be thrown out of employment. This machine was the origin of all hosiery

and lace machines, and its main principles are embodied in the machines of the present day. The first fabric made by Lee was of flat even-selvaged nature so that garments had to be cut from the knitted material, but he soon learned to shape the fabric by adding or dropping loops. This process is known as fashioning, and all the better class garments of to-day are fashioned. Lee received no encouragement for his invention in England and went to France, where he built up a flourishing industry for a time. Later he lost all he had and died in poverty. The industry was revived during the eighteenth century and several additions to the machine were made. One improvement, a rib machine, made a more elastic material which was alike on both sides. By the middle of the nineteenth century, 50,000 of Lee's hand frames were in use. Up to this time only a flat web could be knitted.

Growth of knitting industry. — After the invention of the latch needle in 1858 there was a revolution in the knitting industry and many new machines were invented. The most important part of these machines is the needles, — the latch needle, which opens and closes automatically, thus making the loop and also producing a hard solid material, and the spring needle, which makes a looser, more elastic fabric. The seamless hosiery of to-day is made on a circular knitting machine of American origin. All sorts of garments are now knitted on many varieties of machines. The industry has grown very rapidly during the last thirty years.

Knitted products. — Knitted goods are manufactured to a greater or less extent from all of the important textile fibers. They are used more extensively each year, and include gloves, sweaters, underwear, hosiery, leggings and ties. Jersey cloth, a knitted fabric made in silk and wool, is very much used and may be purchased by the yard. Some napped fabrics, such as eiderdown and flannel, have

also been made with a background of knitting. Knitted goods of the rib variety are stronger and wear better but are more expensive than plain knitted goods. Rib and plain knitting are often combined in the same garment. Great quantities of knit goods are now made in Germany, England, France and the United States. The mills in the United States are located chiefly in Pennsylvania, New York and Massachusetts. The topic "knitted goods" is also discussed in Chapter IV, Cotton.

QUESTIONS

1. Distinguish between a woven and a knitted fabric.
2. What is one distinction between the warp and woof thread?
3. Explain the method by which the check pattern is obtained in a gingham apron; the changeable pattern in a silk petticoat.
4. Name 5 materials, each illustrating a different weave.
5. How many different weaves can you find among the garments you are wearing?
6. Compare the method by which the pattern was obtained in the following: a challie dress, a damask napkin.
7. State whether the design in the following fabrics is structural or surface:

a. Madras shirt waist
b. Flowered lawn dress
c. Damask tablecloth
d. Galatea middy blouse
e. Challie dress
f. Calico apron

8. What is meant by the term "full fashioned" hose?

Questions and Problems for Further Study

1. Compare the methods used to vary the design: (*a*) variations in weave; (*b*) variation in the use of color; (*c*) variations due to method of finish.
2. To what extent is the knitting industry carried on in the United States? To what do you attribute an increased use of knit goods?
3. Compare a knit garment with a woven one as to (*a*) durability; (*b*) usefulness; (*c*) cost; (*d*) comfort of wearer.

CHAPTER IV

COTTON

Origin of cotton
The cotton plant
Classification of cotton
    Sea Island
    Upland
    Egyptian
    South American
    East Indian
Countries raising cotton
Cultivation of cotton
    Soil and climate
    Planting
    Cotton picking
    Ginning
    Cotton seed as by-product
    Baling
    Cotton bales
Marketing of cotton
    Grading
    Selling
Manufacture of cotton
    Centers of manufacture
    Treatment of cotton after reaching factory
Finishing processes
    Lisle finish
    Mercerization
    Printing of cotton
    Imitations of silk, wool and linen
Finished products
    Yard goods
    Ready-made articles

Knitted goods
Laces
Embroideries
Thread and notions

Cotton is the most widely manufactured of all textile fibers. The fiber comes from the seed pod of the cotton plant and it varies in length from $\frac{1}{2}$ to $2\frac{1}{2}$ or 3 inches according to its variety and the conditions under which it is raised.

Origin of cotton. — There is little doubt that India was the first home of the cotton plant, and that cotton fabrics had reached a high degree of perfection there fully 600 years before the Christian era. Cotton was used for clothing in the early days of human history, but its introduction into Europe was very slow. The Moors introduced its manufacture into Spain, and it was later carried into Europe, although as late as the sixteenth century its use was not common. Many curious notions existed concerning it; one was that the cotton was the fleece of a sheep which grew on a plant. It was not until the year 1621 that cotton was cultivated for the fiber in the United States, although Columbus found it in the West Indies, Cortez in Mexico and Magellan in Brazil.

The cotton plant. — The plant is a perennial, reappearing without planting for several years, but as it is easily killed by frost in cold countries, new seed must be planted every year. For this reason in the United States it is treated as an annual. It grows to a height of from four to six feet. The leaf of the plant often varies in shape on different parts of the stem. The flower is somewhat like a hollyhock, with five whitish or yellowish petals. The blossoms last a day and drop off, leaving a pod which increases in size and finally bursts in sections, disclosing the cotton fiber or cotton boll. There are many different classifica-

Fig. 37. — The Cotton Plant.

tions of cotton, but the important varieties are grouped as follows:

Classification of cotton. — *Sea Island cotton.* — This is the best and has the longest and the finest fibers. It has a light creamy tinge and is lustrous. The seeds are small and black, and are easily separated from the lint, as the cotton is called. This variety is used in making the finest cotton goods — lace, gauze, fine muslins, and silk imitations. It may be spun into very fine thread. It is grown on the islands off the coasts of the Carolinas, Georgia and Florida, and to some extent on the mainland.

Upland cotton. — The Upland cotton is the variety which furnishes most of the supply for the great staple lines of cotton goods. The fibers are shorter than Sea Island, averaging about $\frac{3}{4}$ of an inch to an inch in length. The seeds are covered with a greenish down and the fibers adhere closely to them. American cotton is divided into New Orleans or Gulf cotton, Uplands or Boweds and Texas cotton. The largest fiber crop in the United States is the Upland cotton, grown throughout the South.

Egyptian cotton. — Egyptian cotton ranks second to Sea Island. The fiber is from $1\frac{1}{4}$ to $1\frac{1}{2}$ inches in length, and the color varies from white to brownish yellow. There are two main varieties, the long staple brown and a white cotton. Large quantities are imported into this country every year and used in the manufacture of underwear and hosiery. It is also used in making fine fabrics and spool cotton. It was formerly cultivated only in the lower parts of the Nile Valley, and the brown color of much of it is caused by the muddy waters of the Nile.

South American cotton. — Peruvian and Brazilian cottons have a fiber longer than Upland, but not quite so long as the Egyptian. Peruvian cotton is strong and rather harsh

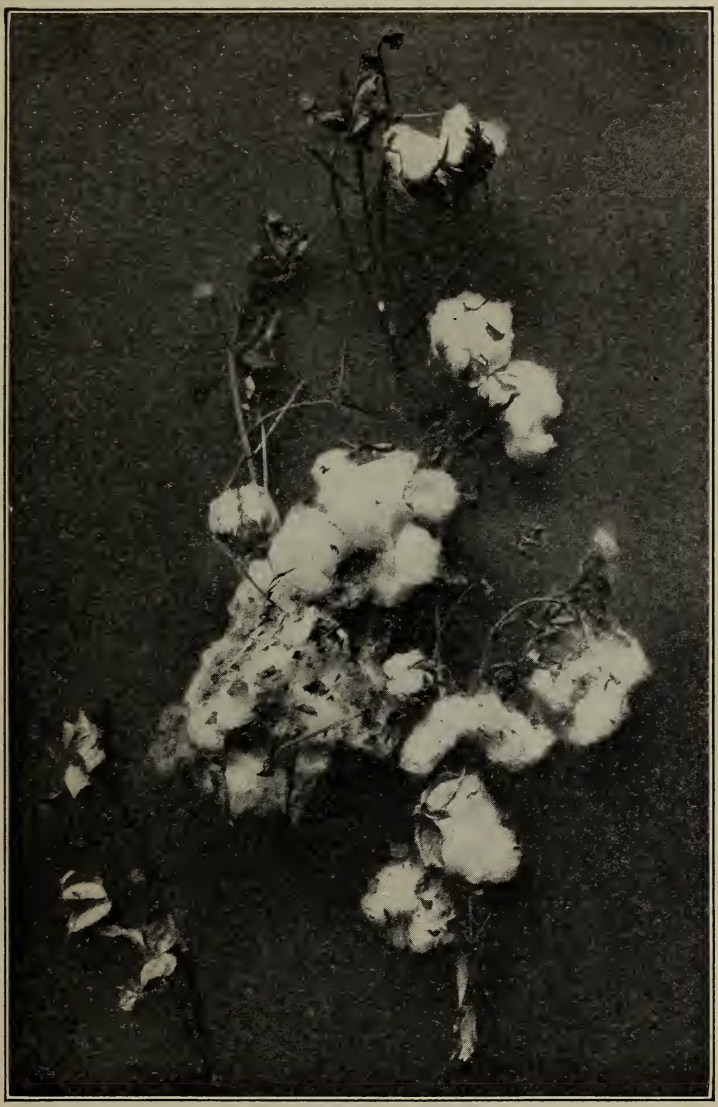


Fig. 38. — Cotton Bolls.

and wiry. It is more like wool and for this reason is used in making woolen mixtures.

East Indian cotton. — The Indian cotton is coarser and shorter in fiber and has not such a good luster, but as a rule it is very strong. It is used in making coarser materials than American cotton — as denims, canvas, duck.

Countries raising cotton. — Cotton may be raised between 35 degrees north and 35 to 40 degrees south of the equator. The United States alone produces about two-thirds of the cotton in the world. India produces about one-fifth and Egypt one-tenth; Egypt exports more than India. The rest of the world's product is grown principally by Peru, Brazil, China and Russia. Both Russia and China grow large quantities of cotton, but not much of it is exported. Texas grows more than any other state in the United States, and the other Gulf states, as well as Georgia, Tennessee and the Carolinas, are also large producers. The American crop in 1916–1917 was 12,356,944 bales with a value of over one billion two hundred million dollars. In most Southern states cotton growing is the chief agricultural industry.

Cultivation of cotton. — *Soil and climate.* — Cotton thrives best in a warm, humid atmosphere, with plenty of rain and a light loamy or sandy soil. It needs much moisture, but the soil must not be wet or mucky. It grows best in a moist even climate with warm breezes and good rich soil. Frost is very harmful. The conditions in the southern part of the United States are most favorable.

Planting. — Cotton is planted in March or April. The ground must be carefully prepared, after which the seeds are sown in rows about four feet apart. When the seeds have sprouted the " chopping out " process or thinning out begins. The surplus plants are killed by a cut from the hoe, so as to leave the plants about 12 inches apart. This process and the picking of the cotton are the two great

expenses in cotton cultivation, as both are still done by hand labor. During June and July the plants grow very rapidly, and the blossoms and then the bolls appear. As soon as the boll is formed a fight against the insect pests which infest the cotton begins. The cotton boll weevil, which

FIG. 39. — PICKING COTTON.

destroys the fiber in the boll before the bolls are ripe, is the most destructive of these pests. The boll weevil originally came into Texas from Mexico, and has since spread over nearly all the South in spite of the constant fight of the United States Department of Agriculture against it.

Cotton picking. — The bolls mature in August and then cotton picking with all its attendant excitement begins. There is a rush for the cotton fields from all over the South,

and it is difficult for employers of colored labor to keep their employees at that time. Men, women and children work in the fields from early morning until late at night. The cotton is gathered by hand, for although many machines

FIG. 40. — COTTON FIELD IN TEXAS.

have been invented for cotton picking, none of them have ever proved equal to judging satisfactorily between ripe and unripe cotton. Each field is gone over at least three times, as the bolls do not all ripen at the same time. The pickers have long sacks on their backs into which the cotton is dropped and which are then emptied into baskets for weighing, which is done at the end of each day. An expert

picker can gather about 250 pounds in a day, though some have picked 300 pounds. The usual pay is from 45 to 50 cents a hundred pounds. The cotton picking season lasts from August to December.

Ginning. — After the cotton is gathered the next process is the removal of the seeds, of which each boll contains

FIG. 41. — COTTON GIN.

from 30 to 40. This is called ginning. When perfectly dry the cotton is loaded into a wagon and hauled to the ginnery, where the seeds and fiber are separated and the cotton baled. There are two kinds of gins in common use

to-day: the saw gin and the roller gin. The seeds of the Sea Island cotton are more easily removed than those of other varieties, and because that cotton is more valuable it is ginned by the roller gin. The *roller gin*, as first used in India, consisted of a flat stone with a round wooden roll worked by the foot, and would gin about 5 pounds of cotton a day. The modern gin, the McCarthy gin, was invented about 1840. In this, a leather-covered roller revolves toward the blade or "doctor," and being rough on the surface draws the fiber under the blade and away from the seed. A comb knocks the seed away from the doctor and the cleaned seeds fall through slots in the feeding table. The fibers are cleaned from the rollers by a revolving brush and passed on out of the gin. This gin does little damage to the fiber, but the production is limited, and but 1000 pounds or so a day can be ginned.

For all other varieties, and they make up the largest amount of cotton, the saw gin is used. This was invented in 1792 by Eli Whitney. Whitney was a northern man teaching school in a cotton district in the South. The old method of ginning was a laborious task, as a man could clean but a pound of cotton a day. Whitney realized this difficulty and invented the gin, one of the greatest inventions in the history of the textile industry. Without this or a similar invention the cotton industry would never have grown to its present tremendous importance. The saw gin consists of a box or chamber, into which the cotton is fed, and one side of which is a grate of metal bars. From 40 to 80 rapidly revolving notched saws catch the fiber and pull it from the seed through the grate, allowing the cleaned seeds to fall to the ground. The cotton fibers clinging to the teeth of the saws are removed by a rapidly revolving brush which, aided by a current of air, throws the cotton on the floor of the gin house. A gin of 60 saws

will gin ten bales, or 5000 pounds, a day. There are many movable gins at present, worked by steam, which are taken from place to place. One gin can handle all the cotton within a considerable radius, perhaps ten miles.

The saw gin does much damage to the cotton, as the idea seems to be to gin as much cotton as possible rather than to gin the cotton as well as possible. The planters are unwilling to obtain sufficient machinery to do the ginning well, since it is in use but four months in the year and lies idle the rest of the time. The modern gin sucks the seed cotton from the farm wagon, separates the lint from the seed and returns the baled cotton, with the seed separate, to the same wagon within an hour.

Cotton seed as by-product. — Up to forty years ago the cotton seeds were considered as refuse and were not utilized except as fertilizer. They are now used in a variety of ways and are of great value, selling at present (year 1917) at $60 a ton. The by-products are:

1. Linters or down, which remains on the seed and is removed by a second ginning. This is used for poor grades of cotton cloth, cotton batting and wadding, and in making explosives. In 1917 it is worth 10 to 20 cents a pound.

2. Hulls, the outside portions of the lintless seeds. These are used in making paper, as a cattle food, and as fuel for producing power, the ashes being used afterwards as fertilizer.

3. Inner seed or "meat." From this oil is extracted by pressure. After the oil is pressed out, the remaining portion is known as "cottonseed oil cake," and it is ground to make cottonseed meal. Cottonseed oil has become a very valuable product; much of it is sold as salad oil, and it is also used in combination with other fats in making soaps and various cooking compounds.

Baling. — After the cotton is ginned, about two-thirds in weight remains as seed and one-third as cotton fiber. The cotton fiber, or lint as it is called, is baled or compressed

FIG. 42. — COTTON ON WHARF, CHARLESTON, S. C.

into as small a space as possible so that it may be readily shipped. This baling is usually done at the ginnery. The cotton is conveyed to a huge box, the bottom of which is the size of a bale, pressed into the box into as small a space as possible, covered with jute bagging and bound with sheet-

iron bands. The size of the American bale is usually 54 inches × 27 inches × 27 inches. The quantity varies, but the average weight is 500 pounds, and 1500 pounds of seed cotton is necessary to produce it. For export the

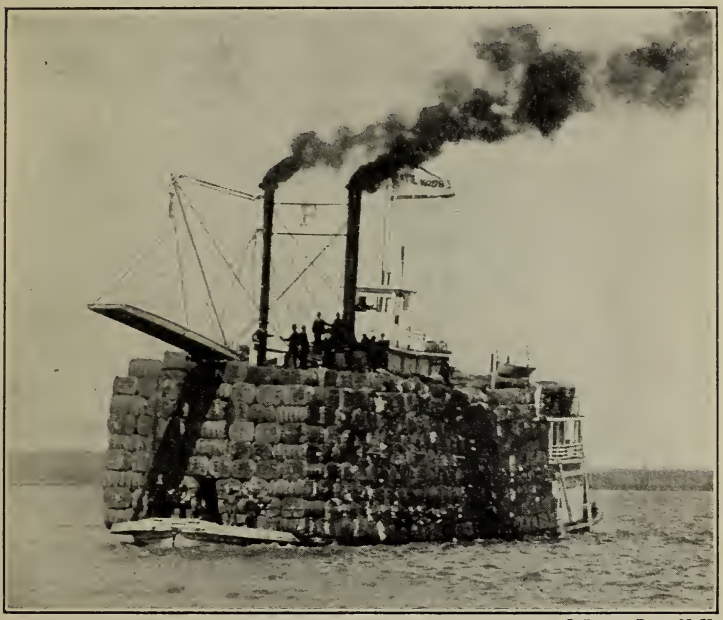


FIG. 43. — COTTON BOAT ON RIVER.

cotton is rebaled by a machine called the Morse Lever Press. The cotton is subjected to a pressure of terrific force which reduces it in size, the covering and steel bands being fastened about it before the pressure is removed.

Cotton bales. — Much criticism has been made of the American cotton bale, as the bales usually reach their destinations with torn coverings, and the cotton fiber in bad condition.

The Egyptian bale is a square bale. A stouter covering is used, and the cotton reaches the merchant in much better condition.

The Indian bale is considerably smaller than the American, is more closely compressed, and has a tie running spirally around the bale. The weight is usually about 400 pounds.

The cylindrical or Bessonette bale is a new idea in baling. When it came out some years ago it was hailed by many as filling a long-felt want, but it has not been so universally accepted as was hoped, as the workers do not take kindly to change. In this bale a machine presses out the air and winds the cotton into a solid roll in the same way that cotton batting is rolled. The bale is entirely covered with cloth and a sample attached to the outside. One reason for its slow acceptance may be the difficulty of packing a round bale for shipping.

English spinners have complained that the cotton coming from America was in worse condition than that coming from any other place. In 1906 an effort was made to correct this, and the Lancashire Cotton Manufacturers Association sent a commission over to the United States to report on American methods of baling and shipping. This commission traveled extensively over the South and made recommendations to the cotton growers for improving the handling of cotton. Some of these suggestions have been acted upon with profit; but the greatest amount of good has been brought about by the constant efforts of the agricultural colleges, through Farmers' Institutes, and the publications of the United States Department of Agriculture.

Marketing of cotton. — *Grading of cotton.* — All cotton is graded according to quality, so that the buyer may know what he is buying. Samples of cotton are carefully examined for length of fiber, coarseness, color and luster, freedom from dead or unripe fibers, dirt, leaves or moisture. A certain amount of moisture, about 4 per cent, is allowed, but if there is more than that, the cotton brings less money. About 5 per cent of the total weight is also allowed for tares, *i.e.* coverings and dirt.

There are set terms in cotton grading, based on the condition of standard middling upland cotton. Better grades are listed above this and poorer below. There are nine distinct grades recognized

in all cotton markets, ranging from Fair to Middling, then to Ordinary. Fair is the highest grade; Ordinary, the lowest.

Selling of cotton. — Cotton is sold either to cotton spinning mills, or to regular cotton merchants, by a local merchant who buys the cotton from the farmer. Sometimes it is not sold at once and these merchants have large storage houses where the cotton is held until shipped. A great deal of cotton is sold abroad. To facilitate trading in cotton, regular market places, called cotton exchanges, in which the buyers and sellers meet, have been established in the larger southern cities and in New York. Two sorts of sales are made in the cotton exchanges, "spot sales" and "futures." In a spot sale the cotton is delivered at once; and in a future the cotton is delivered at some future time.

Liverpool, Bremen, Havre, New York, and Boston are the great cotton markets of the world. At each of these places are large cotton exchanges, whose sole purpose is to promote commerce in raw cotton. The prices made at these exchanges govern the cotton markets everywhere else. New cotton is constantly coming into the market, American cottons at one time, Egyptian at another, while Brazilian and Indian cotton are shipped throughout the year. The greatest amount of cotton trading takes place at Liverpool. The price of cotton (1917) ranges from 17 to 30 cents a pound.

Manufacture of cotton. — *Centers of manufacture.* — The greater portion of cotton fabrics are manufactured in the United States, England, Germany, British India, Russia, Japan and France. In the United States this is mostly carried on in three regions: New England, the Middle States and the South. New England leads in manufacturing the finer grades of cotton cloth, the Middle States in knit goods, and the South in coarser cotton materials. Fall River, Massachusetts, is the largest cotton manu-

facturing town in the world, with over four million spindles and a product of 2000 miles of cotton cloth a day.

The South has made remarkable progress in cotton manufacture since the Civil War and many mills have sprung up along rivers and streams where power is accessible. Labor is cheaper there than in the North, labor laws are less strict and the cotton fields are near at hand, and it may happen that the South will some day lead in cotton manufacture.

In Japan the factory production of cotton fabrics is unimportant compared with the home production. In many of the homes cotton is woven both by hand and power, and enormous amounts of material 14 inches wide are produced and sold in bolts of twelve yards each. It is estimated that 100,000,000 bolts of this material are produced every year.

Treatment of cotton after reaching factory. — 1. Opening. — When the bales of cotton reach the factory, the first thing to be done is to break the bands and remove the covering. The cotton is in a tightly compressed mass and must be opened up and made to look as it did after the seeds were removed. The first machine to which it goes is known as the *bale breaker*. This takes the hard lumps of cotton, breaks them up into smaller pieces and sends them on to another machine, called an *opener*, which continues this breaking up process. One machine will open about 8000 pounds of cotton in 24 hours.

2. Mixing. — After the bales are broken, several processes follow closely. First several different bales of cotton are mixed together until a uniform grade is assured. The picker machine then takes the cotton in the loose form, beats out the sand and foreign matter, and sends it on in the form of a thin lap somewhat resembling cotton batting. If the cotton is very dirty, it is sent through machines known as scutching machines where it receives still more cleaning.

3. Carding. — The *carding* process is one of the most important. The hand cards of Colonial days are described and pictured in Chapter II. The same process goes on in the big carding machines of to-day. The cotton enters the machine as a soft lap about 39 inches wide. The machine disentangles the fibers, cleans them and draws the lap into a thin layer, and then forms it into a light rope known as a sliver. The slivers pass from the machine and are wound spirally into a deep tin can.

4. Combing. — For finer grades of cotton goods, including hosiery, thread, laces, knitted underwear and mercerized materials, the cotton is *combed.* The comb removes all short fibers and straightens and makes parallel those which are of uniform length. It is an expensive operation and is only applied to the better varieties of fiber, — Sea Island and Egyptian, which are used in the manufacture of high grade materials. There is much waste in combing, but the cotton waste thus combed out is used in making a cheap grade of material.

5. Spinning. — From the combing machine the cotton sliver passes through several different machines which draw it out until it is finally ready for spinning. *Spinning* finishes up the process of drawing and gives the yarn the required amount of twist. Two types of machines, the " mule " and the ring frame, are used. The finer yarns are spun on the mule. (See Chapter II.) The ring frame is an American invention and counts below 60 are usually spun upon it. By " count " is meant the number given to yarn of all fibers but silk to indicate its fineness. The size number in cotton yarns depends upon the number of yards of yarn required to make a pound. In the United States the unit is 840 yards and Size 1 would have 840 yards to a pound. Yarn Size 10 would have 8400 yards to a pound. In speaking of the quality of raw cotton, the manufacturer

states what size yarn it will spin. Sea Island cotton, so it is claimed, can be made into yarn as fine as 400, that is, a pound would spin 336,000 yards. Cotton used as filling is spun into much finer yarn than if used as warp, as the warp must always be stronger.

Dr. Nystrom in his "Textiles" gives some interesting statistics concerning what can be manufactured from a pound of cotton. Any of the following can be produced: $1\frac{1}{2}$ yards of denim, 4 yards of sheeting, 6 yards of gingham, 7 yards of calico, 10 yards of lawn, 25 handkerchiefs, or 56 spools of No. 40 sewing cotton.

6. Bleaching and Dyeing. — Cotton yarn becomes a yellowish color during the process of preparation and it usually requires bleaching; this is done by chemicals. The dyeing is done, as a rule, in the yarn. For both *bleaching and dyeing*, the cotton is wound in hanks. Some fabrics are bleached in the piece.

7. Weaving. — (See Chapter II.) About one-half of the labor cost of cotton production is represented by the *weaving*. Most of the standard cottons are plain weave and are woven on an ordinary power loom, but there are many novelty materials made on special looms or on the Jacquard loom.

8. Knitting. — A large quantity of cotton yarn is used in the manufacture of knit goods and sent to the knitting mills, where it undergoes a different treatment. (See Chapter III.) The knitting yarns are given special twists in spinning.

Finishing processes. — The finish on many of the cotton fabrics on the market is produced chiefly by the method of treating the cloth after weaving. Various substances, including starch, clay, mucilage, glycerin, wax and ammonia water, are used to bring about different results. A soft supple finish is given by glycerin, fats or oils, and waxes; a

firm full finish by the addition of starch, and by much pressing; the gloss of percalines, dress linings and cambric by treatment with mucilage, gums and ammonia water. To secure a high degree of luster the cloth is alternately calendered and mangled. The process of calendering consists in passing cloth through a machine having heavy rollers or cylinders, sometimes heated, which are in close contact with each other. Calendering flattens the fibers, removes inequalities, and gives a glaze to the surface.

The stiffness needed in Swisses, tarlatans and lawns is produced by mucilage and gum. Cretonnes and canvas are weighted with clay to give a solid appearance. Much of this finish passes off in laundering, but the original appearance is partly restored by starching and stiffening. Many of the finishing processes are expensive and greatly increase the cost.

Lisle finish. — Lisle finish is given to yarns to be used in the manufacture of hosiery and underwear. Combed, long-stapled Sea Island or Egyptian cotton is used for the best grades. The yarn is rapidly and repeatedly run through gas flames until the projecting fiber ends are thoroughly singed off and a smooth glossy thread is produced. Sometimes the finished fabric is treated with a weak solution of sulphuric or hydrochloric acid, and then dried and later immersed in an alkaline bath.

Mercerization. — An important process is mercerization, in which the cotton is treated with strong caustic alkalies which cause the fiber to contract, gain in strength, and acquire a resemblance to silk. This process was discovered about 1850 by John Mercer, but had little commercial value until about 1880. Since then the process has become very important, and in 1889 a patent was taken out by Lowe for a new method which brings out the luster without the great shrinkage of the older process. Several improve-

ments have been made, but the process remains essentially the same, and consists in immersing the cotton yarn or piece, under tension, in strong cold caustic soda or potash solutions, and then washing it. The best quality of cotton, Sea Island or Egyptian, is used and the fiber is generally combed and "gassed," *i.e.* singed in a gas flame, to remove ends and make it more silky. Cotton may be made to appear mercerized by giving it the Schreiner finish. This appearance is produced by passing the cotton under engraved calenders, with pressure. This wears off when materials are laundered.

Printing of cotton. — The designs on cotton goods are frequently printed on the cloth instead of being woven in. (See Chapter II.) There are several methods of printing:

1. By *resist*, which consists in printing the pattern on the cloth with chemicals in such a way that the pattern will not be affected when the cloth is placed in the dye.

2. By *discharge*, in which the fabric is dyed and the pattern printed upon it later and then treated in such a way that the color in the design is removed.

3. By the *direct method.* Direct printing or calico printing, as it is sometimes called, was formerly done by wooden blocks on which the designs were traced in copper bordered strips of felt; just as the impression of a rubber stamp is made on paper. It is now done by means of copper cylinders on which the patterns are etched or engraved, there being a cylinder for each color in the design. These revolve against flat rollers which are in contact with the color troughs. Any excess of color received by the cylinder is removed with a knife.

The design is prepared by two different processes. In one method the die is cut out of soft steel which is hardened and then pressed against soft steel to make another die with the reverse of

the pattern. These dies reproduce the pattern along the length of the copper cylinder. The other method of preparing the design is by the pantagraph. A copper roller is thinly coated with wax and placed in the pantagraph. The operator places the design before him and with a steel point goes over every line and figure of one color in the design. This steel point is connected with a lever moving twenty similar points in contact with the waxed surface of the roller. The lines of the design are thus reproduced in the wax on the roller, as the wax is scraped off wherever the points touch the copper. When the entire area of one color in wax has been scraped off the surface of the cylinder in this manner it is placed in an acid bath which eats away the copper wherever it is exposed, and after the remaining wax is removed, the design remains etched on the surface of the cylinder. This process is repeated with as many rollers as there are colors in the pattern. All the rollers are of exactly the same size and are so adjusted in the printing machine that each color is placed on the cloth at the exact points shown on the design. Eight different colors can be printed at one time and varied so that twelve or thirteen distinct shades may be secured. When the warp yarns are printed before the fabric is woven, an effect of an indistinct design is produced.

Imitations of silk, wool and linen. — Many cotton fabrics are made to imitate either silk, wool or linen. The *silk effects* are largely secured through mercerization. Cotton sateen is made to look like silk partly through the weave, by treatment with glycerin, and by much calendering. By using silk patterns with mercerized cotton yarn, the cotton pongees are made. Velvets, velours and corduroys are woven in a special way to give the nap. (See Chapter II.) They undergo elaborate finishing processes, are brushed, shorn, brushed again, singed and brushed. In cheap velveteens the colors are put on the surface in a stain and frequently wear off. They are finally finished by waxing the pile surface side and giving it a final brushing.

Cotton is made to look like wool in various ways:

1. By using special methods in preparing the yarn.
2. By using wool or worsted patterns in weaving.

3. By chemical treatment in which the yarn is made to look like wool.

4. By treating the cotton in such a way that the dye used for wool will act upon it.

5. By finishing and calendering with rollers covered with cloth which comb up a nap, or by passing the cloth through a shearer which produces the nap. Outing flannel, pile goods and blankets are passed several times over cylinders covered with wire teeth which comb the fiber.

Cotton is made to look like linen by the use of dressing which gives it body, and by pressing and beetling (see Chapter V) which produces the appearance of shiny long smooth fibers of flax. In towels and cotton damask the yarn is spun with small knots in it at irregular intervals; the designs in weaving are the same as those used for huck toweling and damask, and the dressing is the same as for linen. Unfortunately, after laundering, the cotton towel or napkin loses the appearance of linen and becomes fuzzy and lusterless.

A great deal of cotton is used in combination with wool, silk and flax; sometimes the two different fibers are spun together, but more often the cotton is used as either warp or filling.

Finished products. — *Yard goods.* — The greatest amount of cotton is doubtless manufactured into yard goods, and under yard goods may be classified:

1. Underwear Materials. — All materials used for *underwear*, including cambric, long cloth, nainsook, etc. Such materials should be soft, launder easily and wear well. For general hard wear, long cloth and Berkeley cambric give excellent service. Nainsook is one of the most satisfactory materials for making light, thin garments. Cotton crêpe is an inexpensive material, and is very practical for underwear, as it needs no ironing. Poplin, chambray and piqué are often used for petticoats as well as for dresses.

Outing flannel and flannelette are used a great deal for nightdresses and pajamas. The table of cotton goods on pages 92 to 99 should be consulted for other important facts concerning yard goods.

2. Dress Goods. — Cotton *dress goods* are classified as:

(*a*) Thin materials, including dimities, lawns, organdies, voile, mull, etc., used for light summer dresses, baby clothes, etc.

(*b*) Slightly heavier materials, including gingham, madras, percale, used for serviceable dresses and shirt waists.

(*c*) Heavy materials, including poplin, galatea, Indian-head muslin, kindergarten cloth, piqué, used for middy blouses and skirts, children's rompers, etc.

(*d*) Linings, percaline, sateen and some mercerized materials.

(*e*) Materials made to imitate wool, cotton serge, flannelette, corduroy, which are used a great deal in place of wool for children's school dresses when the price of wool is prohibitive.

3. Domestics. — *Household furnishings*, such as cretonne, chintz, sheeting, toweling, curtain material.

Ready-made articles. — Formerly all clothing and bed linens were purchased by the yard and made either in the home or by a seamstress. In late years all this has been changed, and it is possible to purchase all varieties of wearing apparel ready made, and also such things as sheets, pillow slips and kitchen towels. In some cases it is economy to purchase them in this way.

The following table gives the relative cost and sizes of some of these. In selling sheets, the price quoted for cotton sheets refers to single sheets, while in linen sheets the price quoted is for a pair. The prices quoted in this table are average prices for good quality in normal times.

COTTON "BED LINEN"

ARTICLE	SIZE	AVERAGE COST
Counterpanes	Single — Three quarters and double	
Honeycomb or Crochet	Single — Three quarters and double	$ 1.60 to $3.25 per yard
Crinkled Dimity	Single — Three quarters and double	1.35 up
Imported	Single — Three quarters and double	3.50 up
Satin Marseilles	Single — Three quarters and double	3.25 up
Comfortables, cotton filled		2.00 up
Pillow slips	42″×36″	.20 up
	45″×38½″ (Regular size 22″ pillow)	.29 up
	50″×38½″	.32
	54″×38½″	.34
Pillow tubing	for regular size pillows	.27
Sheets	Single 54″×90″	.70 to 1.30
	Single 63″×99″	1.12 to 2.00
	Three-fourths 72″×99″	1.22 to 2.50
	Large 90″×99″	1.60 to 3.45
Towels	Medium size 22″×40″	1.50 doz. up
Turkish toweling	18″×36″	2.50 doz. up
	27″×63″	24.00 doz.

Knitted goods. — Cotton knitted goods consist chiefly of underwear, hosiery and gloves. Mercerized cotton sweaters and sweaters made of cotton imitating wool are manufactured.

1. Underwear. — A large proportion of knit *underwear* is of the ribbed variety (see Chapter III, Knitting), and is as a rule stronger than plain, and more valuable because of its tendency to conform to the shape and the motions of the body. A new top, called Band or French top, for the neck

and sleeves of underwear, consisting of a knitted band instead of a crochet edge, has been found to wear better than the older type. Underwear can be purchased in single garments or in one-piece suits. Undervests made of a poor quality of cotton are on the market for 10 cents each, but an average price (year 1917) for good quality is about 40 cents. Combinations or union suits sell from 75 cents up with a good quality at about $1.25. Fine mercerized garments made of the best Sea Island cotton cost about $2. Fleece-lined cotton garments are made as a substitute for wool and cost from $1 to $2.

2. Hosiery. — Hosiery is known as *cut goods*, *seamless*, or *full fashioned*. *Cut goods* are the cheapest and are knitted upon a circular knitting machine which produces a long roll of fabric. This is cut into pieces of the length of the stocking, which are then cut again and sewed to fit the leg or are shrunk into shape. Heel and toe are then added and in some cases a ribbed top, and the stocking is scoured, dyed and shaped. The heavy seam is objectionable. They are made in all sizes for men, women and children, are the cheapest grade of stocking on the market and can be purchased for 10 cents a pair.

Seamless hose are made by a specially constructed machine upon which the entire stocking is made and the toe piece joined to it by a special attachment. They are made in a great many different qualities and include most of the cheap holeproof guaranteed stockings. The chief objection is a looseness around the ankle, as the upper part of the leg and the ankle are made the same size. A good quality of seamless hose may be purchased for 25 cents a pair.

Full fashioned hose are best, as they conform to the proportions of the leg and foot. They are made on expensive knitting machines which knit the stocking in a flat piece, dropping the correct number of stitches to narrow toward the

ankle and shape the heel and the toe. They are made in lisle or plain cotton and cost from 35 cents to 85 cents according to quality.

3. Gloves. — The manufacture of cotton *gloves* is a branch of the hosiery industry. The fabric is knitted in flat pieces and then sewed together to form the glove. Of recent years a washable cotton glove made to imitate kid and selling for from 50 to 75 cents per pair has been much used.

Laces. — All lace may be grouped under three heads: Needle-point, pillow lace and machine-made lace.

1. Needle-point. — This is handmade or real lace, made with a needle. The pattern is first drawn upon a piece of parchment which is then sewed to two pieces of linen. Threads forming a skeleton pattern are laid upon the parchment and fastened to it by stitches. The pattern is then filled in with buttonhole stitching, and between these various parts are worked ties called " brides " which unite them and reproduce the pattern. A knife is passed between the two pieces of linen at the back of the parchment, cutting the stitches which have held the framework together and releasing the lace.

2. Pillow Lace. — Handmade lace made with bobbins upon a pillow is known as *pillow lace.* It is made by a method somewhat like weaving in which threads are twisted and plaited to follow the pattern. The pattern is first pricked on paper or parchment and the paper fastened to a pillow or cushion which varies in shape in different countries.

Each thread is wound upon a bobbin and the bobbins are interwoven about pins placed in the pillow in the shape of the pattern. As a certain motif is finished the pins are removed and placed farther ahead in the pattern, and the process repeated. The distinction between the two varie-

ties of handmade lace is the use of the needle and buttonhole stitch in the needle-point and the interweaving of the threads by bobbins in the pillow lace. Before the present war the chief sources of handmade lace were France, Belgium, Ireland and England. It is one of the oldest of textile industries, and exquisite examples of old lace may be found in museums. Belgium produced more lace than France in 1900. The pattern which is principally made there is Point de Gaze. Ireland produces great quantities of Irish crochet lace made with a crochet needle. Real baby Irish lace may be told by little picots or loops throughout the pattern.

3. Machine-made Lace. — *Machine-made lace* imitates both needle-point and pillow lace. The greatest quantity of lace nowadays is made by machinery and comes from England, France and Germany. The application of the Jacquard apparatus (see chapter on Weaving) to lace machines has enabled the manufacturers to produce all kinds of patterns in imitation of handmade lace.

Wonderful results have been achieved by a patent circular lace machine in Nottingham, England, the productions of which can scarcely be distinguished from handmade pillow lace of the same style. France has also manufactured a great deal of machine-made lace. A large amount of very good lace is made in Zion City, Illinois.

Common Laces

Cluny. — A coarse thread bobbin lace used for underwear and dress trimmings. It has a square net background, and is a plaited lace made in both linen and cotton.

Filet. — Lace made with a square mesh, usually linen.

Footing. — An insertion of plain Brussels net, from one to three inches in width. Used as trimmings.

Galloon. — A lace insertion with a scallop edge woven on each

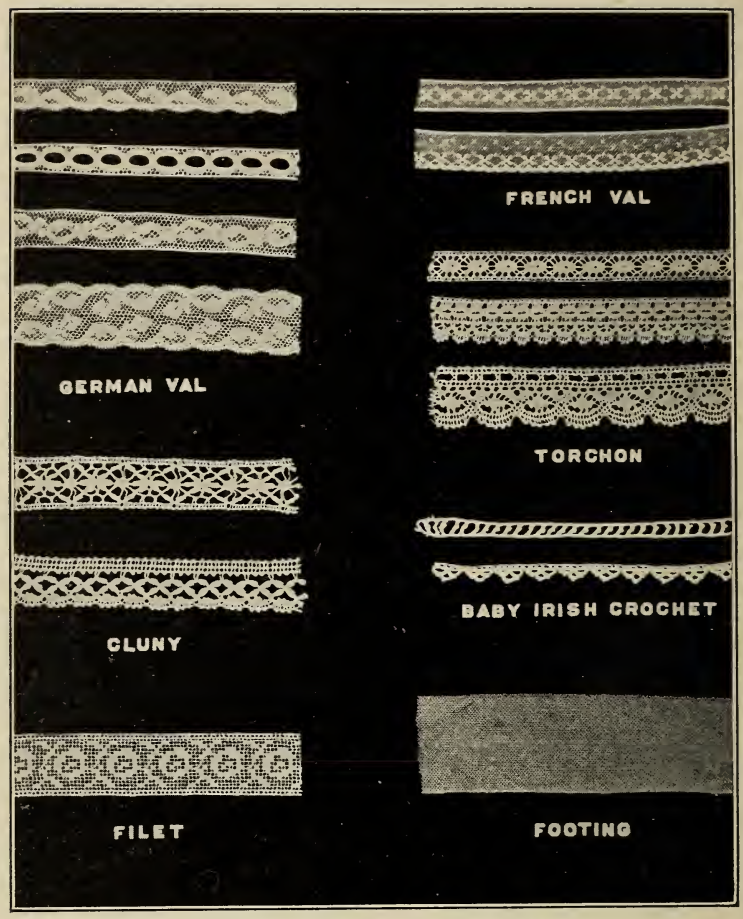


Fig. 44. — Some Standard Laces.

side, sometimes made in irregular or zigzag form. Used as banding on dresses.

Honiton. — An English bobbin lace first made in Honiton, Devonshire. Made also as a machine-made narrow braid that may be made into lace.

Maltese. — Coarse pillow lace. Patterns are formed of plaiting or cloth stitch. Has no definite mesh. Used for dresses.

Point de Paris. — Originally a narrow pillow lace but now applied to machine-made cotton laces of simple pattern and inferior quality; the net is hexagonal in form.

Torchon. — Bobbin lace made of loosely twisted thread in simple patterns. Made in narrow widths in cotton and linen. Used for underwear. Has excellent wearing quality.

Valenciennes. — Usually spoken of as Val. Cheap cotton bobbin lace, made into narrow edgings, insertions and beadings, and used for underwear and dresses. Known as French Val where the mesh is diamond shape and German Val where the mesh is round. German Val when made of strong thread wears excellently.

Embroideries. — Embroideries are usually classified according to the type of cloth upon which the embroidering is done, as cambric, nainsook, batiste, Swiss or voile. The background of the embroidery should be similar to the garment upon which it is to be used. Handmade embroideries are very expensive, but a hand-finished embroidery may be purchased the edges of which are finished by hand and which is less expensive.

The best embroideries are made in St. Gall, Switzerland, and very good ones are made in Plauen, Germany. The latter are stronger and give excellent service. Many fine embroideries are made by the nuns in France. They are made on a hand loom and come in four and one-half yard strips. This French embroidery is of a bluish tint and is called *Madeira*. American factories are imitating it now and it is difficult to distinguish the imitation from the hand work. Handmade embroidery presents the same appearance on both sides. A cheaper quality of embroidery made on a machine is called the Schiffle and the sides are not alike. The Schiffle machine has been much improved in recent years, and a very good quality of embroidery is now made upon it. Embroidery is sold as embroidery flouncing,

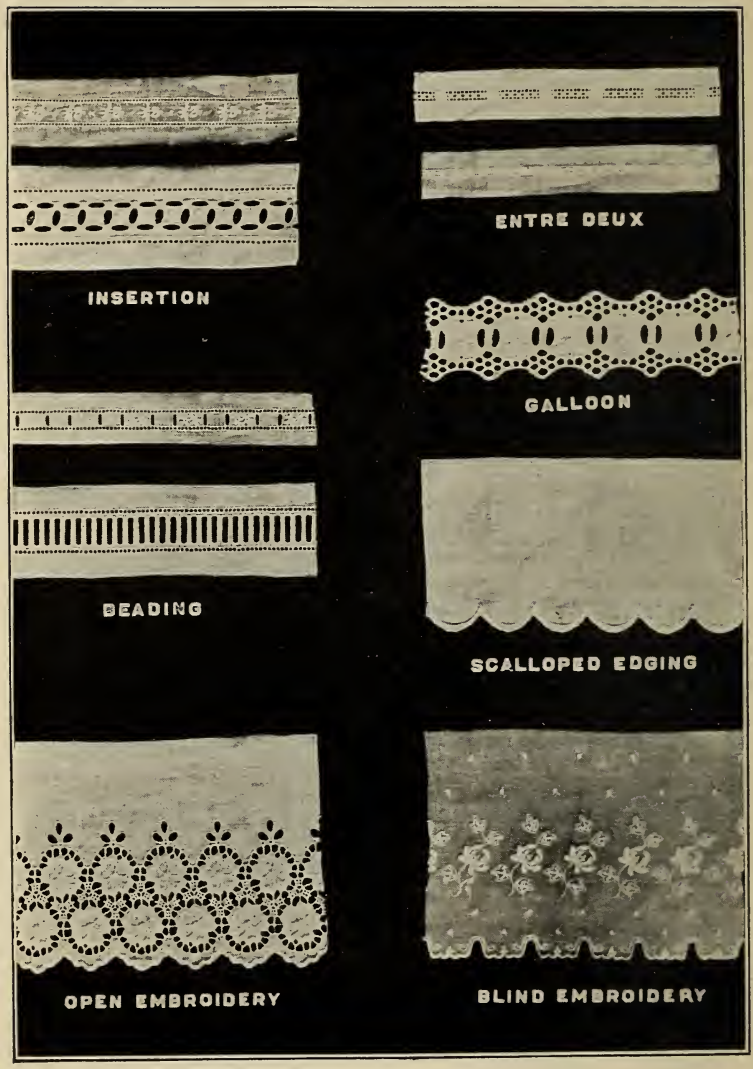


FIG. 45. — EMBROIDERY EDGES AND BEADING.

edging, insertion, beading and entre deux. *Entre deux* is a narrow beading used to join the seams of lingerie and children's garments. A good embroidery should have a solid, firm edge. Solid embroidery showing no holes is often called *blind embroidery.*

Thread and notions. — A large amount of cotton is manufactured into spool cotton, crochet, embroidery and darning cotton and into the various dress findings found at the notion counters. Cotton thread is made by twisting several cotton yarns of the very best cotton fiber together to form a stronger thread. Two yarns are twisted together, then three of these doubled yarns are twisted again to make the thread commonly called six-cord spool thread. The size of the thread is controlled in the twisting process. The thread is wound into hanks ready for bleaching and dyeing. After bleaching, the thread is wound on bobbins, is sized or gassed and then wound on spools. The dyeing is done while the thread is in the skein.

The original basis of sizes of sewing thread was formed when it was spun and twisted into three-cord for hand sewing. When three strands of No. 40 yarns were twisted together, the size of the thread was called No. 40 in spite of the fact that it was three times as large as No. 40 yarn. All other sizes were likewise determined. With the advent of the sewing machine and the need for a smoother, stronger cotton, six-cord cotton was made; the numbers were not changed but the yarns used were twice as fine, leaving the actual size of the thread the same as when only three strands were used. No. 40 thread, when three-cord, is made of No. 40 cotton yarn, but No. 40 six-cord is made of six threads of No. 80 yarn. This is true of all thread made in American mills.

The following table lists the articles in common use with approximate prices.

Thread	sewing	5 cents a spool
Cotton	crochet	12 cents a ball
Cotton	darning	5 cents a ball
Cotton	embroidery	2 skeins for 5 cents
Tape	twilled	3 to 5 cents a piece
Bias seam binding	lawn or cambric	12 to 15 cents a piece
Mercerized	skirt braid	15 cents a piece
Belting	2 to 4 inches wide	8 to 15 cents a yard

QUESTIONS

1. What are the important varieties of cotton?
2. Name several cotton products made from Sea Island cotton.
3. Why would Sea Island cotton be used for mercerized stockings and upland cotton for gingham aprons?
4. Outline the growth of cotton from the planting to manufacture.
5. Of what value was the invention of the cotton gin?
6. Compare the two types of cotton gins.
7. How important a part does a cotton exchange play in the industrial world?
8. What are the important processes in the manufacture of cotton?
9. Of what value commercially was the discovery of the mercerizing process?
10. To what extent is cotton used to imitate other fibers?
11. What is the distinction between real lace and the ordinary lace in general use?
12. *a*. Tell the names of the cotton fabrics from which the cotton garments you are wearing are made.

b. Name 10 cotton materials in common use. Give width, use and price per yard.

Questions and Problems for Further Study

1. To what extent are the ideas worked out by Eli Whitney still followed in the cotton gin of to-day?
2. Outline fully all the products made from the cotton seed, and state their uses.

3. What different machines have been tried for the picking of cotton, and how successful have they been ?

4. Make a comparison of the treatment during manufacture of a knitted cotton garment and a woven one.

5. How would a knowledge of textiles aid a girl selling neckwear ?

COTTON

Name	Price	Width	Weave
Batiste	29¢–$1.25	38″–44″	Plain
Bird's-eye	25¢ up	27″–45″	Pattern
Bobinet	75¢	45″	
Brussels Net	85¢–$1.75	50″–3 yd.	
Buckram	25¢	19″–27″	Double weave
Bunting	10¢–25¢	27″	Plain
Calico	12½¢	25″	Plain
Cambric	20¢–30¢	36″	Plain
Canton Flannel	18¢–35¢	27″–36″	Twill
Chambray	35¢	30″	Plain
Cheesecloth	10¢–25¢	36″	Plain
Chintz	35¢–75¢	27″–36″	Plain
Corduroy	98¢–$3	31″–40″	Pile
Crash	12½¢–15¢	15″	Plain, twill
Crêpe	25¢–35¢	30″	Plain
Cretonne	25¢–$10	36″–50″	Plain, twill
Crinoline	10¢	27″	Plain

MATERIALS

Character	Use	Wearing Quality
Sheer, fine, light cloth. Made from fine yarn. Many qualities. White and some colors	Waists and children's clothes	Good
Fabric woven small pattern resembling bird's-eye; like diaper	Diapers	Excellent
Cotton net with hexagonal meshes. White	Curtains	Good
Open weave net with round mesh. White	Waists, neckwear	Excellent
Coarse-woven material heavily sized, very stiff	Hat frames	Good
Soft, light plain cloth, loose weave. Made in solid colors and white	Flags, decorations	Fair
Printed cotton cloth. Pattern on one side. In England name for cotton. First made in Calcutta, India	Dresses, aprons	Good
Fine fabric with glazed smooth surface. Lonsdale and Berkeley cambric good varieties. Berkeley 100 good for underwear	Underwear	Excellent
Heavy material, nap on one side. Bleached and white	Underwear, linings	Excellent
Fine gingham, plain colored warp, white filling. Calendered	Dresses, aprons	Excellent
Thin, light weight, like bunting; no sizing. White and colors	Curtains, dust-cloths, wrapping cheese	Fair
Printed fabric, large flowered design in colors	Curtains and draperies	Good
Heavy ribbed material with pile. White and colors	Skirts, curtains, dresses	Excellent but pile mats down
Rough, coarsely woven material. White and unbleached	Towels	Fair
Thin material with crinkled surface. White, plain colors and flowered. Does not need ironing	Underwear, dresses	Good
Upholstery material. Bright, flowered patterns printed one side	Curtains, upholstery	Excellent
Stiff, sized cotton cloth, loosely woven. White, gray, black	Linings, stiffenings	Loses stiffness

COTTON

Name	Price	Width	Weave
Damask (Cotton)	48¢–98¢	64″–70″	Pattern
Denim	25¢–35¢	36″	Twill, pattern
Diaper — See Bird's-eye			
Dimity	12½¢–35¢	27″	Corded, plain
Dotted Swiss	20¢–25¢	36″	Lappet
Drilling	17¢–25¢	30″	Twill
Duck	18¢–25¢	27″–36″	Plain
Eiderdown	69¢–$1.19	36″	Knitted, pile
Flannelette	25¢	30″	Plain
Flaxon	25¢–50¢	32″–40″	Plain, corded
Gabardine	50¢–$1.25	36″	Twill
Galatea	30¢	27″–30″	Twill
Gingham	10¢–60¢	27″–36″	Plain
Huckaback	25¢–50¢	18″–27″	Pattern
Indian Head	29¢–35¢	36″–44″	Plain
Jean	22¢	36″	Twill
Khaki	30¢–75¢	27″	Twill

MATERIALS — *Cont.*

Character	Use	Wearing Quality
Pattern fabric, imitation of linen. White	Table linen	Good but soon gets fuzzy
Heavy material, twill face and plain back. Plain colors, sometimes stripes or checks	Curtains, upholstery	Excellent
Corded surface, thin material representing bars or stripes. White and flowered	Dresses, aprons, waists, curtains	Fair
Thin material woven with small dots. White	Dresses, curtains	Good
Strong, firmly woven white cloth	Middies, men's night shirts	Excellent
Heavy coarse material like canvas. White	Skirts, middies	Excellent
Thick, soft fabric with knitted foundation and surface, with thick woolly nap. Plain colors and patterns	Infants' coats, bathrobes	Good
Soft narrow flannel like outing flannel. Slight nap. Colors printed on plain surface	Kimonos, dressing sacks	Good
Material much like dimity made to imitate linen. White	Waists, aprons	Good
Heavy cotton material like whipcord. White and plain colors	Dresses, skirts	Excellent
Heavy material like drilling. White and plain colors	Children's dresses, middies	Excellent
Universally used fabric. Plain, and plaids and stripes	Dresses	Excellent
Toweling woven with honeycomb face called "huck." Imitation of linen	Towels	Good but not equal to linen
Heavy white fabric like duck	Skirts, middies	Excellent
Heavy twilled cloth like drilling. White and some colors	Corsets, men's clothing	Excellent
Cloth dyed yellowish tan; made unshrinkable; finished for hard wear and used for military uniforms. East Indian word meaning clay color. Waterproof	Uniforms, camp fire costumes	Excellent

COTTON

Name	Price	Width	Weave
Kindergarten Cloth	25¢–50¢	36″	Plain
Lawn	10¢–50¢	27″–44″	Plain
Long Cloth	15¢–30¢	36″	Plain
Madras	25¢–$1.50	36″	Pattern
Marquisette	25¢–60¢	36″–50″	Gauze
Masalia Cloth	50¢–69¢	40″	Plain
Mull	35¢–50¢	32″	Plain
Muslin	12½¢–30¢	36″	Plain
Nainsook	25¢–65¢	36″–45″	Plain
Organdie	25¢–$1.25	36″–45″	Plain
Outing Flannel	12½¢–25¢	27″–36″	Plain
Percale	25¢	36″	Plain
Percaline	30¢	36″	Plain
Piqué	25¢–75¢	27″–36″	Plain, corded
Pillow Tubing	25¢–35¢	36″, 40″, 42″, 45″	Double
Poplin	35¢–50¢	27″–36″	Plain, corded
Ratine	50¢, $1.00, $1.75	36″–50″	Terry or pile

MATERIALS — *Cont.*

Character	Use	Wearing Quality
Firm, plain, colored material	Rompers, dresses	Excellent
Soft, smooth-finished, starched sheer fabric. White and colored. Sometimes called India Linon	Aprons, dresses	Good
Soft, finished, bleached muslin. Usually sold in 12 yd. pieces	Underwear	Excellent
Usually striped or in small patterns. First made in Madras, India	Shirtings	Good
Sheer, light, open weave material	Curtains	Excellent
Fine white material like nainsook. Slight luster	Infants' dresses, underwear	Good
Thin, soft material, sometimes starched. White and colored silk mull — cotton warp and silk filling	Dresses	Fair
Firmly woven, white and unbleached. Wamsutta, Lonsdale, Pride of the West, Alpine Rose, Fruit of the Loom all good	Underwear	Excellent
Soft, finished material made in many grades	Underwear, children's clothes	Good
Fine, translucent muslin, plain and flowered	Dresses	Good, but washes poorly
Soft, thick material brushed to look like flannel. Nap both sides. Plain and striped or checked	Nightgowns, pajamas	Excellent
Close, firm-woven cambric, dull finished. Printed pattern	Dresses, aprons	Excellent
Piece-dyed, fine light-weight material, glazed or moiréed. All colors	Linings	Excellent
Heavy fabric having raised surface of lateral cords. White	Skirts, dresses, infants' coats	Excellent
Casing of muslin woven in a seamless tube	Pillows	Excellent
Fine cord across cloth, fine warp thread, heavier filling. White and colored	Dresses, waists, middies	Excellent
Fabric with small tufts on surface. White and colored	Skirts, curtains, dresses	Good

COTTON

Name	Price	Width	Weave
Sateen	30¢–75¢	27″–36″	Satin, twill
Sheeting	59¢–65¢	1¾, 2, 2¼ yd.	Plain
Scrim	25¢–30¢	36″–40″	Plain
Seersucker	25¢	30″	Plain
Silesia	15¢ up	27″	Twill
Silkaline	18¢	36″	Plain
Surgeon's Gauze — See Cheesecloth.			
Swiss Muslin	25¢–75¢	30″	Plain
Tarlatan	15¢	53″	Plain
Ticking	39¢–45¢	32″	Twill
Turkish Toweling	25¢	20″–36″	Terry
Velveteen	75¢–$1.50	27″–36″	Pile
Veiling	25¢–$1.50	18″ up	
Velour	75¢ up	36″–42″	Pile
Voile	25¢–85¢	36″–46″	Plain

Note. — Standard materials are described in these tables, with the tion. Poorer grades will show poorer wearing qualities. The

MATERIALS — *Cont.*

Character	Use	Wearing Quality
Smooth, lustrous surface; glossy, soft to touch. Back shows twill	Linings, petticoats	Excellent
Muslin woven wide to use for bed sheets	Sheets	Excellent
Open-mesh strong material, heavy thread. Bleached and unbleached	Household furnishings, curtains	Excellent
Woven in stripes, alternate stripes crinkled or crêped	Rompers, dresses	Excellent
Smooth-finished, fine, light-weight goods, plain colors	Linings	Excellent
Soft glazed cotton, printed on one surface, like silk	Curtains	Good
Fine sheer muslin, sometimes embroidered	Blouses, dresses	Good
Thin sized cloth of netlike weave, slightly stiffened. Colors. Like mosquito netting	Drapery	Fair
Heavy twilled material in stripes	Pillows, mattresses	Excellent
Heavy-weight rough material woven with loops on both sides	Towels	Excellent
Velvet woven entirely from cotton	Trimmings, coats, dresses	Good
Open tissue, made in many varieties	Veils	Good
Material with soft nap on one side. All colors	Upholstery, curtains	Good
Semi-transparent fabric, light in weight	Waists, dresses	Excellent

wearing quality that attaches to a good grade of the fabric in ques-
prices quoted were current in 1917.

CHAPTER V

FLAX

History and antiquity of linen
Cultivation
- The plant
- Soil
- Weeding
- Pulling

Processes of separating fiber
- Rippling
- Retting

Further cleaning processes
- Breaking and scutching
- Hackling

Manufacture
- Sorting
- Spread board
- Spinning
- Weaving

Finishing
- Bleaching
- Use of sizing
- Beetling

Countries producing flax
- Russia
- Belgium
- Ireland
- Scotland, France, Germany
- United States

Finished product
- Table linen
- Toweling
- Laces, underwear and other products

History and antiquity of linen. — Flax has been cultivated for over four thousand years, and linen, the manufactured product of flax, has probably been used as a textile material longer than any other fiber. Drawings of the ancient Egyptians show processes of spinning and weaving flax, and linen materials of fine quality have been found wrapped about mummies. In the Bible we read that Pharaoh clothed Joseph in "vestures of fine linen." Linen was probably first manufactured by the Egyptians and reached the rest of the world through the Phœnicians. In Ireland in the year 500 A.D. the people owned fine linen, and in the eleventh century linen was woven there. Since the Industrial Revolution and the invention of the cotton gin, cotton has replaced linen in many of its uses; but it can never be as valuable because of the strength, luster and beauty of linen.

FIG. 46. — THE FLAX PLANT.

Cultivation. — *The plant.* — The flax plant probably came originally from Egypt and can be made to grow in nearly all countries and all climates. The plant is an annual and has a straight, slender stalk. It grows from 20 to 30 inches in height and has numerous small flowers of a bluish color. The seeds are small brown seeds, flat and smooth. The flax fiber (see Chapter I) consists of a few fine

hairlike threads running up and down through the center of the stalk of the plant. It is much stronger than cotton, but is more easily injured by chemicals. When the seeds are planted far apart the plant branches out near the ground, and more seeds are produced. When grown for fiber, the seed is sown thickly in order that tall, slender stems free from branches may be secured.

Soil. — The soil should be carefully chosen and the ground well cultivated in order to produce the best fiber. A good, deep, well-plowed soil is necessary, and a moist climate is desirable. Flax cannot be grown for many years in succession on the same soil to good advantage but should be rotated with other crops. This rotation of crops is practiced in Belgium but not to the same extent in this country. The seeds are sown broadcast in March or April.

Weeding. — When the plants are two or three inches high they should be very carefully weeded by hand. In Europe this is done usually by women and children, who go over the fields on their hands and knees. No particular care is needed after weeding until the harvesting in July or August, when the plants are pulled up by the roots.

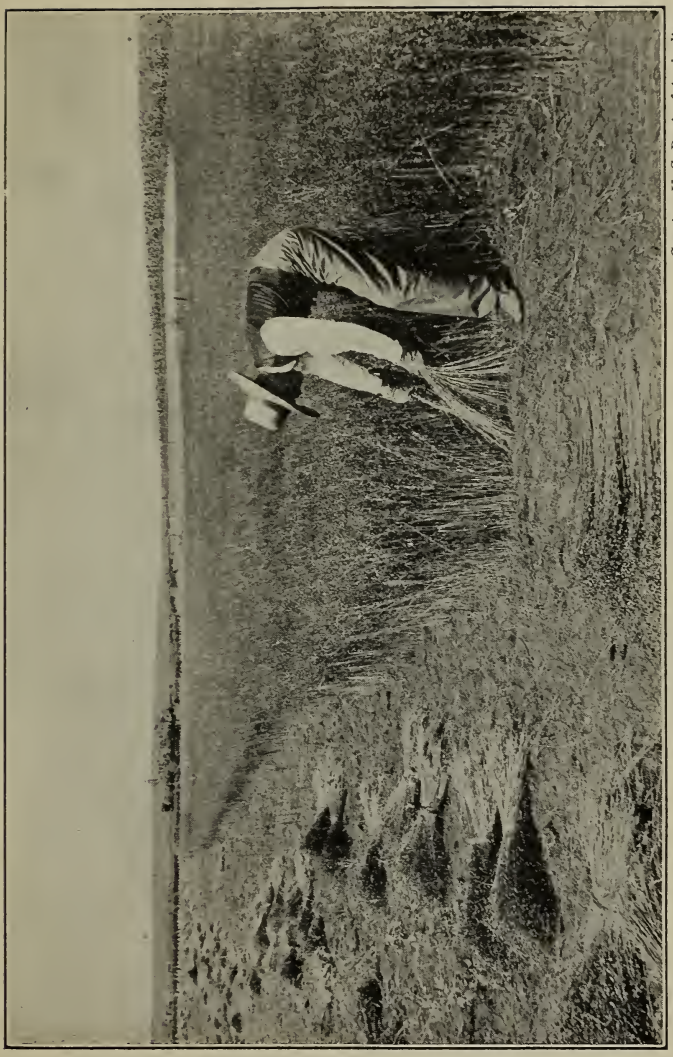
Pulling. — Flax is in the best state for fiber when the leaves and stem of the lower part turn yellow and the seed pods begin to ripen. All the plant, including the roots, must be pulled up by hand because if cut

(1) several inches of every fiber are wasted;

(2) the sap of the fiber runs out and the quality of the flax is inferior;

(3) a blunt end results instead of the natural taper of the fiber, and this prevents its use in fine fabrics.

Pulling by hand is a tedious and expensive process but as yet no satisfactory flax pulling machine has been invented. The stalks are then allowed to dry for about ten days either



Courtesy U. S. Dept. of Agriculture.

FIG. 47. — PULLING FLAX.

hanging in bunches on fences or racks, or piled in stacks, or by an artificial process such as kiln drying.

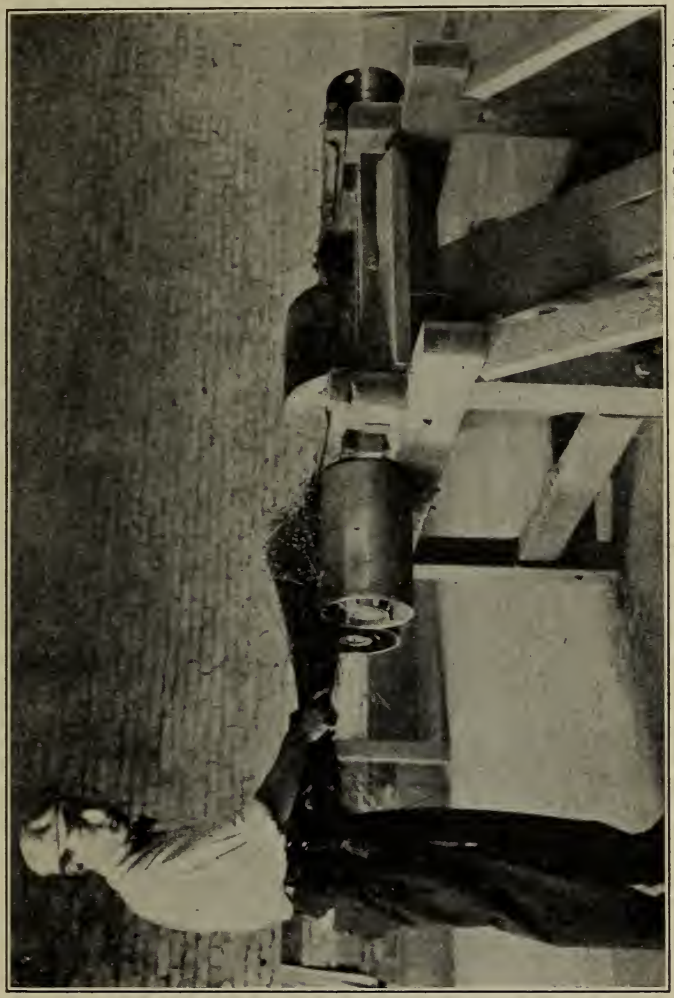
Processes of separating fiber. — *Rippling.* — After the stems are thoroughly dried, the seeds and leaves are removed by rippling. This was formerly done by hand, and consists in drawing the bundles of flax across rakes or boards

Courtesy U. S. Dept. of Agriculture.

Fig. 48. — Field of Fiber Flax at Harvest Time. Bunches of Pulled Flax.

filled with spikes which pull off the seed pods and leaves. At present, the flax bundles are held up against revolving cylinders which crush off the superfluous matter. After rippling, the stalks are tied up in bundles and are ready for retting or for storage. The flax is now spoken of as flax straw.

Retting. — One of the most important processes in the preparation of flax is the *retting* or rotting of the outer stalk



Courtesy U. S. Dept. of Agriculture.

FIG. 49. — RIPPLING FLAX.

of the flax straw so that the inner fiber may be easily removed. If this process is successfully performed, the color, strength and luster of the fiber are unimpaired. The straw is treated so that, through the presence of bacteria, fermentation sets in, separating the bark and woody pith from the fiber. The adhesive matter holding the flax together is called pectose, and during the retting this is changed to soluble pectin and insoluble pectic acid, both of which are washed away.

There are four methods by which this process may be performed.

1. Dew Retting. — In *dew retting* the flax is spread in rows over a wet meadow and allowed to remain under the action of the dew and sun for several weeks. During that time decay sets in, and the fiber may be easily removed. This is the method used in Russia and it produces a flax of a gray color, darker than flax produced by other methods.

2. Pool Retting. — In *pool retting* the bundles of flax are immersed in pools of stagnant water for about 10 days. There is danger of overretting by this process, as an excess of organic matter hastens fermentation. Overretting causes the fibers to be brittle and weak. Pool retting is the method used in Ireland, and it produces a flax of a bluish gray color.

3. Stream Retting. — This method is similar to pool retting except that the flax is soaked in streams of running water. The famous Courtrai flax of Belgium is retted in this way in the waters of the river Lys. The flax is placed in open crates of wood, with burlap around the sides to keep the dirt out. The crates are covered with straw and then weighted down with stones and sod until they are about six inches below the surface. For fine fiber the flax is sometimes taken out after five days, dried for half a day, and put back for further retting. About two weeks is needed for this method. The water of the river Lys seems to be especially adapted for retting, and the flax is remark-

Courtesy U. S. Dept. of Agriculture.

FIG. 50. — FLAX STRAW SPREAD FOR DEW RETTING.

FIG. 51. — STREAM RETTING IN COURTRAI, RIVER LYS, BELGIUM.

able for color, strength and fineness. Flax straw is sent to Belgium from other countries for retting.

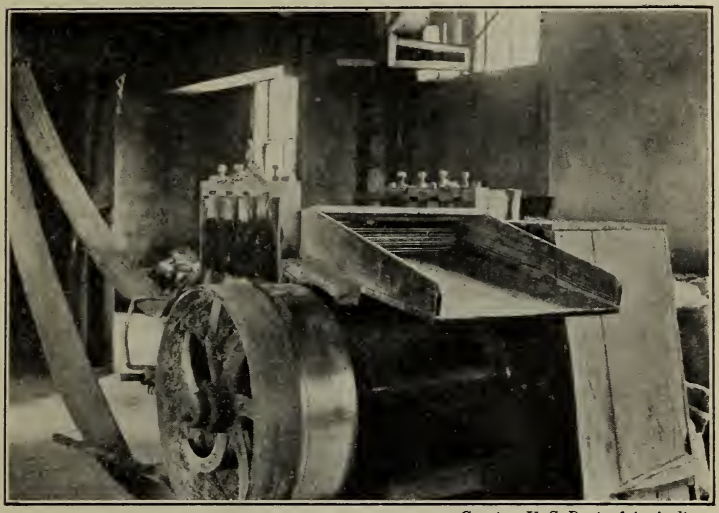
4. Chemical. — Many experiments have been made in an endeavor to shorten, by the use of special apparatus and chemicals, the time and labor required for retting. Oxalic acid and caustic soda have been added to warm water and the process shortened to about 60 hours, but the results have not been satisfactory enough to warrant the flax growers investing in the necessary machinery. Chemicals weaken the fiber and injure the color and thus detract from the value of the product.

Further cleaning processes. — *Breaking and scutching.* — After retting, the bundles of flax are set up or spread out in the fields until thoroughly dry and then run through a machine called a breaker. The process of breaking was formerly, and in some places is yet, done by a flax brake. A series of long bars or slats on a stand have a beater at one end which is brought down again and again on a sheaf of flax placed across the bars. This breaks the woody part in pieces, which drop below, leaving the fiber on the bars. At the present time the result is obtained by using machinery with fluted rollers. The *scutching* is a further cleaning process carried on by a machine with wooden knives or beaters which beat the broken wood and pulp portions out of the fibers and leave them fairly free from impurities.

Hackling. — Hackling is a combing process performed either by hand or machine. The process consists in drawing a handful of scutched flax fibers several times through a set of upright teeth. In this way the short fibers or *tow* are combed out and the long fibers or *line* remain in the hackler's hand. Sometimes several sets of combs with varying sizes of teeth are used. All impurities and loose, short, uneven fibers are combed out, and the remaining fiber is again divided and is ready to be spun into thread.

Fig. 52. — Breaking Flax. Old Way.

The tow is carded and treated very much like cotton, and is made into coarse cheap linen materials. In a machine hackle, series of pins or teeth pass through the flax as it moves slowly from one end of the machine to the other, and the tow is caught in the teeth and later removed by a re-



Courtesy U. S. Dept. of Agriculture.

FIG. 53. — FLAX BRAKE.

Woody portion of retted flax is broken by passing the straw between the fluted iron roller.

volving brush. At the end of the machine an attendant receives the combed flax or line and returns it to a second machine which combs it in the opposite direction. This produces a line which is fine, smooth and glossy.

Manufacture. — *Sorting.* — After hackling, the flax is sorted by hand according to quality, and the product is sometimes called "dressed line." Where the fiber is cut for use in fine yarns it is called "cut line."

Spread board. — The fiber is now carried to the spread board on a traveling apron. The flax is laid by hand on the traveling apron in bunches, each bunch overlapping the other by at least six inches. When it reaches the spread board it passes through a set of teeth which again comb it into a sliver much like the cotton sliver, and make it for the first time into a continuous length. The slivers are doubled and drawn out a great many times and are then sent to the spinning machines.

Spinning. — The spinning of linen is much like that of cotton and worsted (see Chapter II) except for the addition of a trough of hot water through which the linen yarn passes. The water dissolves some of the natural gum and makes a finer yarn. The temperature of the spinning room is kept very high to prevent breakage. Wet spinning makes a finer thread and adds to its strength. The highest numbers, or finest yarns, and the yarns used as warp are spun in this way. Large or coarse sizes of yarn are spun dry.

Weaving. — (See Chapter II.) Flax is woven much as other textiles except that the Jacquard loom is used to a greater extent. Practically all of the damask used as table linen is woven on the Jacquard loom, and a great variety of weaves is produced. The weaving is difficult because the threads break very easily. Much linen is still woven by hand.

Finishing. — *Bleaching.* — The object of bleaching, one of the important finishing processes of linen, is the whitening of the textile fiber. The natural gray or brown color of the linen is undesirable for some fabrics, and the fiber also accumulates stains of various kinds during the spinning and the weaving. Bleaching may be done by "grassing" or "crofting," or by chemicals. In our grandmothers' day the process was accomplished by wetting the cloth with sour milk and spreading it on the grass for several

FIG. 54. — BLEACHING LINEN IN IRELAND.
Linen spread on ground.

weeks. Linen may be bleached or dyed in the yarn or in the fabric. At present, chemicals are used very largely. In Ireland, chemicals are used in the early stages and crofting or grass bleaching completes the process. The bleaching of linen is longer and more complicated than that of cotton, and the linen fabric loses in weight and in strength; in weight about 20 per cent. There are four grades of linen bleaching — quarter, half, three-quarter and full bleaching. Full bleach linen is not as strong as other grades.

Use of sizing. — If the linen is of good quality, not much dressing is added, as the luster of the flax may be brought out in beetling and calendering. Cheap, poor linens are, however, often loaded with foreign substances, such as starch, clay or wax.

Beetling. — The beetling process is used to give gloss to the surface and, also, the leathery feel which is characteristic of good table linen. It flattens and closes up the threads and produces a luster. It originally consisted in striking the woven cloth with wooden mallets after it was washed and dried. Some hand woven damasks are still finished by hand beetling. In a beetling machine the linen is wound on rollers, above each one of which is a series of solid, high, perpendicular blocks with square edges. These move up and down in regular order, pounding every spot of the surface of the linen. The linen is sometimes *cropped* with knives to remove the rough ends and loose fiber. After beetling, the linen is calendered by a process similar to that used for cotton (see Chapter IV), and the cloth is then ready for inspection and folding.

Countries producing flax. — *Russia* produces the largest proportion of the world's supply of flax, but owing to the methods of retting, the fiber is less valuable. The best flax is kept at home because of a prohibitive tariff which

prevents the importation of manufactured flax. Russia is famous for its linen crashes.

Before the present war *Belgium* produced the finest variety of flax on the market, due to careful methods of cultivation and to peculiar advantages for retting in the river Lys. Courtrai ranked highest in the world in the excellence of its flax fibers. Belgium exported fiber to other countries, chiefly France and Great Britain, but had a large manufacturing trade herself. Toweling and table linen as well as finer fabrics were made in large quantities.

Ireland is one of the chief countries cultivating flax, and Irish linen is the best known and the most valuable in American markets. The climate and soil are suitable for its growth, although a good deal of that manufactured in Ireland is raised in Belgium. Belfast is the center of the Irish linen manufacture. Much of the linen grown in Ireland is grass bleached, which adds to its wearing quality. Ireland excels in handkerchief and table linen.

Scotland, France, Germany. — Scotch, French and German linens rank next to Irish. These countries raise flax fiber to some extent, but are more important for their manufactured product. Germany makes large quantities of excellent table linen, but the highest grades are not exported. Scotland also has a high reputation for table damask. Both Scotch and German linen are silvery white in color. French linen has a fine round thread; and fine damask and dress linen are manufactured in France in large quantities. Holland is famous as a place for bleaching linen.

United States. — In this country flax is raised more for seed than for fiber. The seed is used for producing linseed oil, the "drying" oil in paints and varnishes, and also in making linoleum, oil cloth, oil silk, patent leather and other products. As yet no means have been discovered to yield equally good fiber and seed. If fiber is desired, the

plants must be pulled before the seed is fully ripe, for if the seed is allowed to ripen fully before the plants are pulled, the fiber becomes harsh, coarse and woody and cannot be used for fine linens. Small amounts of flax are raised for fiber in Michigan, Minnesota, Oregon and in Canada. Large quantities are raised for seed in the Dakotas, Northern Minnesota and northwestern Canada. The fiber from these plants has been used in making twine and rope, and some satisfactory cheap towels have been placed on the market.

The quantity of linen manufactured in this country is almost negligible on account of the large amount of experienced hand labor required and the high wages paid here for such labor. This labor cost is chiefly for weeding and pulling. The work of retting and preparing the fiber is also not pleasant, and the American laborer can get more congenial work to do. The cost of flax spinning machinery is high, and a flax mill costs four times as much to build as a cotton mill of the same capacity. It has been estimated that the production of the finished linen will require six times the number of laborers necessary to produce a similar quantity of cotton. The rapid growth of the cotton industry in this country has had much to do with keeping down the manufacture of linen.

Finished product. — Linen fabrics were formerly manufactured in larger quantities than all other textile fabrics together, but the growth of the cotton industry, due to the invention of the cotton gin, and the continued high cost of production of linen have driven it down to third place. In the old days linen was the only covering used for the table, and bed linen was what it is called, really linen. Linen bed linen has now been superseded by cotton, and is scarcely found except in the homes of the very wealthy. Linen and cotton are mixed together for toweling and damask

and called "union goods." This adulteration is further discussed in Chapter VIII. The finished products of linen may be outlined as follows:

1. Yard goods. See the table on page 120.
   - Table linens.
   - Dress goods.
   - Art linens.
   - Sheeting.
   - Toweling.
   - Upholstery materials.
2. Laces.
3. Linen mesh underwear.
4. Embroidery threads and floss.
5. Twines and cordage, warps.
6. Heavy sail cloth, tent materials.
7. Aëroplane cloth.

Table linen. — The finest quality of flax and the highest degree of skill in manufacture are required for the fine damask which we desire so much for the dining table. Though linen wrinkles easily when used as a dress material, it lies smoothly upon a table and its firm, smooth, lustrous surface makes it exceedingly desirable for table use. A good damask is elastic, leathery, not too fine, firm, but not stiff and heavy with starch. Bleaching is an important factor in the production of damask, and grass-bleached linen is usually the best. This comes into the market in December, as the bleaching is done in the summer. Damask is made double as well as single, and double damask is the better and more expensive of the two. It is woven with a double thread in the filling with about five picks more to an inch than in the single, and the two sides do not look alike. On the right side the background looks like a twill, while the wrong side looks like satin; in the single damask

the background looks practically the same on both sides. A good way to judge linen is to count the number of threads to an inch. The correct amount for warp in a good double damask of medium quality is 180 threads, and for filling 280 threads. Table linen comes by the yard and when bordered comes in various lengths. Napkins are always to be had in the same design as tablecloths. The Irish linens are considered the best, and are most expensive; Scotch linens rank next in value. German linen is cheapest and gives excellent service although there is not such a variety in patterns.

Toweling. — Linen is the best material for towels because of its power of absorbing water. Huckaback is the most serviceable material for hand towels, and several sizes are made, varying from the small guest towel to a towel 27 inches by 45 inches. Kitchen toweling or glass towels are sold either by the yard or made up into towels. Damask is used but little for toweling. Huckaback and bird's-eye are the principal materials now used. The usual size of towels for family use is 24 inches by 42 inches. Hems and hemstitching are used on the edges; fringe has practically been discarded as it is not enduring. Cheap towels are being manufactured in this country from the flax straw left after the seed is gathered.

The table on the next page gives sizes and average cost of table linen and towels.

Laces, underwear and other products. — Much of the real lace has always been made from flax fiber spun into very fine threads, but the greater part of machine-made lace on the market is made from cotton. Cluny and Torchon are made of linen as well as cotton, and they wear much better when made of linen. A linen Torchon edge about an inch wide costs about 20 cents a yard. Linen Cluny about three-quarters of an inch wide is worth about 35 cents a yard.

TABLE LINEN AND TOWELS

ARTICLE	DESCRIPTION	PRICE
Napkins	Small tea napkins	$3.00 doz. up
	Breakfast 22″	3.50 doz. up
	Lunch 24″	4.00 doz. up
	Dinner 27″	4.00 doz. up
Towels	Kitchen towels	
Made up	Union	2.40 doz.
	Linen	3.50 doz.
	Face towels	
	Union	3.00 doz. up
	Linen	5.00 doz. up
Tablecloths Woven in lengths of 2 yd., 2½ yd., 3 yd., etc.	Single damask	4.00 up
	Double damask	7.00 up
Bleached Irish linen		
Tablecloths	72″×72″	4.00 each
Napkins	24″×24″	5.25 doz.
Luncheon sets	2 size doilies — ½ doz. each 1 centerpiece	4.00 up

Linen thread is used for crocheting and for sewing carpets and heavy articles. Barbour's linen thread comes in spools in bleached and natural color linen and costs 10 cents a spool. Carpet thread is sold in small skeins. Linen floss is used for embroidery, but no great variety of colors can be purchased. Linen tape is also manufactured and a narrow tape called bobbin, about one-eighth inch wide, is used a great deal. It comes looped in small skeins and is much used in lingerie in place of ribbon. Linen mesh underwear has increased in use during the last ten years, especially in men's underwear. The linen is woven in an open mesh, is porous, and is considered very hygienic. Cotton and linen are often woven together in an open mesh and are very satisfactory for undergarments.

LINEN

Name	Price	Width	Weave
Art Linen	59¢–$2.50	18″–2 yd.	Plain
Butcher's Linen	59¢	36″	Plain
Cambric	50¢ up	36″	Plain
Canvas	39¢, 45¢, 50¢	27″, 36″, 40″	Plain
Crash (Russian)	18¢–35¢	12″–16″	Plain
Crash Suiting	39¢–85¢	18″–36″	Plain
Damask	$1.59 up	16″, 72″, 88″	Figure
Diaper	$1.20, $1.75 for 10 yd. bolts	18″ and 30″	Figure
Dress Linen	75¢–$1.25	36″	Plain
Handkerchief Linen	89¢–$2.00	36″	Plain
Holland	40¢–$1.25	27″–36″	Plain
Huckaback	20¢–$1.00	18″–27″	Figure
Sheetings	$1.00 up	All widths	Plain
Tracing Cloth	50¢–75¢	36″	Plain-sized

MATERIALS

Character	Use	Wearing Quality
Soft-finished, plain linen made with round, hard-twisted yarn	Draperies, fancy work	Good
Stout, stiff, heavy, coarse fabric (butcher's aprons)	Aprons, interlinings	Excellent
Fine, thin French cambric, named from Cambrai, France	Dress goods, lingerie	Good
Heavy, firmly woven material, unbleached	Interlinings	Excellent
Narrow material, coarse thread and coarse weave	Towels, art work	Excellent
Heavy, plain, rather coarse weave	Suits	Excellent but wrinkles badly
Pattern fabric woven on Jacquard loom. Bought by yard or in patterns	Napkins, tablecloths, towels	Excellent if good quality
Woven in bird's-eye pattern	Towels, diapers	Excellent
Firmly woven linen, plain and colors	Dresses, suits	Good
Fine, sheer, plain fabric. White and colors	Handkerchiefs, waists, neckwear	Good
Plain, woven linen sized with oil and starch, which makes it opaque. Formerly woven without sizing and used for dresses	Window shades	Good
Peculiar weave shows much of woof thread. Sometimes mixed with cotton and called union goods	Towels	Excellent
Wide heavy material woven wide for sheets. Sometimes bought for dresses	Sheets	Excellent
Thin linen sized on one side, highly calendered and transparent enough to enable tracings to be made	Architectural drawings	

Much of the supply of flax which formerly found its way into the household is now being used in the manufacture of aëroplane cloth — a fine firmly woven material. It has been found that linen surpasses cotton for this purpose because of its greater strength.

QUESTIONS

1. What are some of the characteristics of flax that make it valuable as a textile fabric?
2. Why is linen not used as extensively now as in former years?
3. What process in the preparation of flax has the greatest effect on the quality of the fiber? Why?
4. Compare the various methods of retting flax.
5. Why is linen not manufactured to any great extent in this country?
6. How does the treatment of the flax fiber differ from that of the cotton fiber?
7. What influence has the need for flax seed had upon the manufacture of linen?
8. Outline the important products of linen.
9. Name two standard materials made of flax each showing a different style of weave.
10. Name ten linen materials, tell price, width and use.

Questions and Problems for Further Study

1. To what extent is the flax industry carried on at the present time in Belgium?
2. Discuss the changes in the bleaching of linen from the days of the early colonists to the present time.
3. At what mills in the United States is linen manufactured to any extent? How does it compare with the foreign product in quality and cost?

CHAPTER VI

WOOL

Animals furnishing wool
- Sheep
- Goats

Countries producing wool
- Wool markets
- Wool manufacturing centers

Production of wool
- Care of sheep
- Sheep ranching in the United States
- Washing
- Shearing
- Pulled wool

Treatment in factory
- Sorting of wool
- Scouring and drying
- Further treatment
- Blending

Distinction between woolens and worsteds

Preparation of yarn
- Carding
- Combing
- Further gilling and drawing
- Spinning
- Weaving

Finishing processes
- Dyeing
- Fulling
- Addition of flocks
- Napping or teazling
- Shearing or cropping
- Pressing and other finishing processes

Use of wool substitutes
- Shoddy
- Extracts
- Flocks
- Noils
- Use of cotton

Finished products
- Yard goods
- Carpets
- Oriental rugs
- Domestic rugs
- Tapestries
- Blankets
- Yarn
- Knit goods

Animals furnishing wool. — The raw material from which woolen and worsted fabrics are made comes from various kinds of sheep and goats. A description of the characteristics of these fibers is given in Chapter I.

Sheep. — Wool from different breeds of sheep varies widely in quality. There are many varieties of sheep, and new ones are added frequently by interbreeding. Sheep that are raised for mutton do not yield the best quality of wool, and wool sheep are not particularly palatable food. Wool may be classified as "short wools," "long wools" and "carpet wools."

1. Short Wool. — The best known and the most widely distributed breed of the *short wool* sheep is the Merino, of which there are several varieties. The Spanish merino is the original; the Saxony merino is the finest in quality and its wool is used for underwear and fine broadcloths. The French merino ranks high; this breed is raised to a large extent in the United States where it is known as the Rambouillet. The merino is a rather small sheep well covered with a thick growth of crinkly wool. The fiber is from two to four inches long, is very fine and has many scales or serrations. It may be used for the finest fabrics. The sheep is easily cared for and thrives under merely average conditions.

2. Long Wool. — Other breeds of sheep are known as *long wools*. Of this variety the Lincoln and Leicester are important. The Lincoln is a large sheep bearing a heavy fleece of long lustrous wool, the fiber of which is from 10 to 14 inches long. The wool of the Leicester sheep is similar to that of the Lincoln, but is whiter in color. Both are used in making worsteds and braids.

Courtesy of Mr. Bachelder.

FIG. 55. — FLOCK OF SHEEP.

3. Carpet Wools. — Much wool comes from the unimproved native sheep found in many parts of the world. This wool is less valuable than short or long wools, and great quantities of it are used in the manufacture of coarse *blankets*, *felt* and *carpets*. For this reason it is sometimes called carpet wool. The fiber is coarse and has not many serrations. Not much of this is produced in the United States or in other countries where the value of better sheep breeding is understood. A grade of sheep is much raised in this country that produces both good mutton and wool, though not

the best quality of either. The Southdowns, Shropshire and Suffolk are of this group. The wool fiber is soft, fairly fine and of medium length, and is used in the manufacture of flannels and hosiery. This wool is sometimes mixed with longer wools for woolens and worsteds.

Goats. — The fiber known as mohair is obtained from the Angora goat, an animal indigenous to Western Asia. The fleece has a long fiber from 8 to 15 inches in length, fine in diameter but harsh and wiry, and with little or no curl. It is used for plushes, braids and dress fabrics. Cashmere wool comes from the cashmere goat which is bred in Thibet. This goat produces two varieties of hair, one consisting of soft downy wool, fine and brownish gray in color, the other a long, coarse hair. The wool is remarkable for its softness and is used for the finest of fabrics; the costly India shawls were made from this. Among other animals furnishing wool, the alpaca or Peruvian sheep, which is a species of llama, and the camel are the most important.

Countries producing wool. — The principal wool-growing countries are Australia and New Zealand, Russia, the United States, South America, South Africa, England, Spain and Germany. Australia produces a greater quantity than any other country, Argentina ranks next, and the United States third. Russia has a larger number of sheep than the United States but ranks fourth in the production of wool. In the United States the principal states, in order mentioned, are Wyoming, Montana, New Mexico, Idaho, Ohio and Oregon. The United States raises about two-thirds of the wool it uses in manufacture and imports the rest. Certain wools can be grown cheaper in other countries and certain qualities cannot be raised here owing to the climate.

Wool markets. — London is the great wool market of the world, and the finer grades are taken there and sold to the buyers for woolen mills in England, Europe and the United States. Mel-

bourne in Australia, Buenos Aires in Argentina, and Cape Town in Africa are important markets. The center of the wool trade in the United States is Boston.

Wool manufacturing centers. — Wool is manufactured in large quantities in England, Scotland, Germany, France and the United States. Bradford in Yorkshire, England, is an important center, both as a distributor of raw materials and as a producer of worsted dress goods. All kinds of woolens and worsteds are made in England, and England has always been famous for its woolen and worsted suitings. It has been claimed that Stroud in the western part of England produces the finest woolens in the world. Scotland manufactures great quantities of Scotch tweeds, used as suitings. Woolen factories are found all over Germany and it ranks third as a producer of woolen goods. Many fine wool dress materials, fine serges and broadcloths are made in France. In the United States, Pennsylvania and Massachusetts lead the other states. Providence, Rhode Island, and Cleveland, Ohio, have large factories for the manufacture of worsted cloth. New York ranks high in manufacturing hosiery and knit goods. The first factory for the manufacture of woolens in this country was built at Newbury, Massachusetts, in 1790.

Production of wool. — *Care of sheep.* — The quality and value of the wool are very much affected by climate, food, soil, breeding and cleanliness. The climatic conditions cause great variations in the wool; in cool climates the wool grows more thickly and a moist climate seems to make the fiber longer and more crimpy. The sheep must be carefully shielded from bad weather, as exposure to cold and wet makes the fiber coarse. Proper food is a necessity, as insufficient feeding tends to leave the wool harsh and dry. Sheep must be carefully guarded against disease, as the wool from an unhealthy sheep is poor.

Sheep ranching in the United States. — In the West, sheep raising is conducted as a regular business on the large ranches, although it is giving way rapidly to agriculture. Four-fifths

FIG. 56. — SHEEP SHEARING ON A FARM IN ENGLAND.

of the sheep in the United States are raised west of the Missouri River. In these great northwestern ranches as many as 100,000 sheep are owned by one man. These are divided into a number of flocks of about 1500 head, tended by one man or herder, who stays out with his flock for long periods of time.

Washing. — The washing of wool was formerly done before shearing, by giving the sheep a bath in a tank or brook, but this practice is no longer carried on to any extent. In some cases the wool was washed by the farmer after shearing. At the present time the wool is generally not washed until it reaches the manufacturers, as they seem to prefer it in an unwashed state.

Shearing. — In the shearing process the wool is removed in one sheet called a fleece. Formerly this was done by hand with sheep shears but it is now done almost entirely with machine clippers. The machine shearing saves much wool, as the machine shears get closer to the skin than the hand shears, and a heavier fleece results. A good shearer can shear from 150 to 200 sheep a day. Shearing is now usually done in May. The average weight of a fleece is about eight pounds and it is worth about twenty-five to thirty cents a pound. Each fleece is done up separately and about forty are packed in a bag for shipping.

Special wool from other than full-grown sheep are lamb's wool, wool clipped from an animal 6 or 8 months old, and " hogget " wool, wool clipped from a year-old sheep.

Pulled wool. — Pulled wool is wool removed from the pelts of slaughtered animals by chemicals and is one of the by-products of the meat industries in this country. France buys a large number of these skins from Australia, Africa and Argentina, and the wool is loosened from the skin by a rotting process. Pulled wool does not spin as readily as wool in the fleece, but is valuable for blending with other cheap wools in making medium and low-grade materials.

Treatment in factory. — *Sorting of wool.* — The wool is next sorted by experts according to quality. The quality depends upon the part of the body from which the wool comes, the number of clippings, and the time of shearing as well as upon the care given to raising the sheep, men-

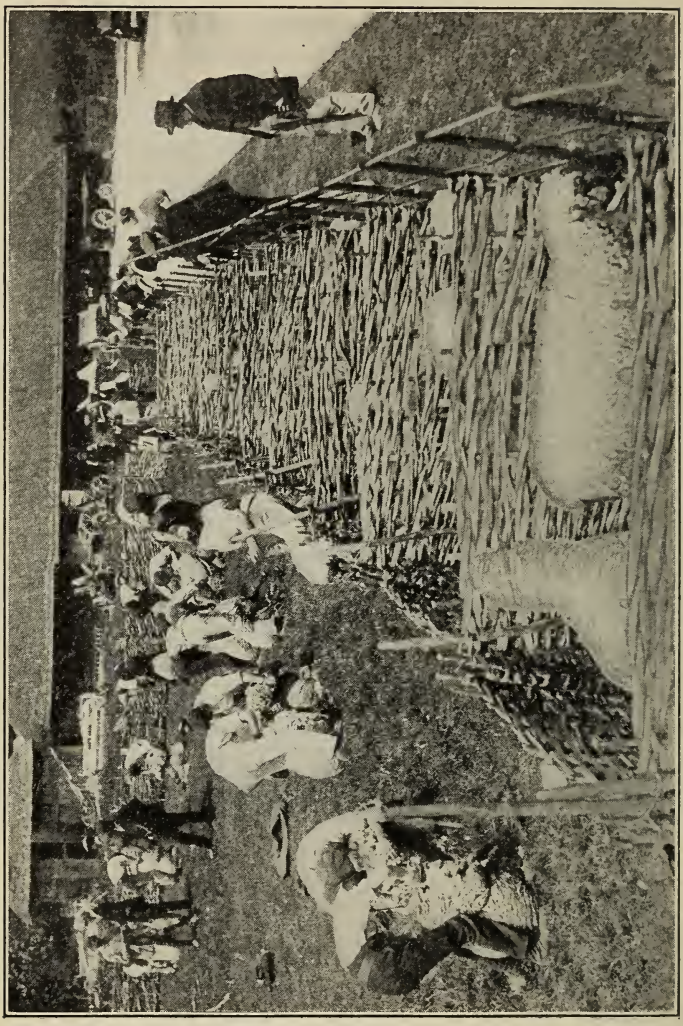


FIG. 57. — SHEEP SHEARING ON A WESTERN RANCH.

tioned in a preceding paragraph. The finest quality is called "pick lock" but this is very scarce. The fleece comes to the factory tied in bundles of 100 to 500 pounds each. Each fleece contains different kinds of fiber, which must be sorted into different grades according to the uses to which they will be put. Some parts are longer and some finer. In sorting, the fleece is placed on a long table with a top in form of a sieve through which the dirt can escape. The best wool comes from the neck, sides and shoulders of the sheep and the poorest from the legs. The sorter works mainly through the sense of touch, tearing the wool out with his hands and throwing the various grades into certain bins marked with the name of the grade. Sorting wool is not a pleasant or cleanly occupation, as the wool is always greasy and dirty and often filled with burs and thistles.

Scouring and drying. — The washing or scouring of wool is necessary, not only to remove the greasy matter or yolk which is secreted by the skin of the sheep; but to get the wool into such a condition that it will spin properly, absorb dyes evenly and produce a well-balanced cloth. The wool is washed by special machines that contain several tanks. The first tanks contain warm, soapy, alkaline water; the latter tanks do the rinsing. Rollers are attached to each tank, and the wool, carried along by rakes, passes through these rollers from one tank to the next, issuing finally clean, white and soft. The by-products left in the scouring water are of great value and are recovered and sold. One of the refined products is called lanolin, and is used as a base for medical salves and in making soap. Another important product is potash.

If the wool is to be dyed, it is then taken to the dyeing machines. If it is not to be dyed, it is dried by hot air forced through the fiber either while spread out on a table or in a specially adapted machine using centrifugal force.

A small amount of moisture, usually about 16 per cent by weight, is left in the wool to facilitate handling. Machines which remove or apply the proper amount of moisture to the wool are called *conditioning* machines.

Further treatment. — In some mills the wool is burred and picked or teased before blending. This opens out the fibers which have become entangled and removes the burs and other impurities not removed in washing. They are taken out either by a machine which beats them out of the wool mechanically, or by a chemical process which carbonizes the vegetable matter. The wool is treated with sulphuric or hydrochloric acid for several hours and then dried and subjected to such high temperatures that the foreign matter is burned out. The acid destroys the vegetable matter present but does not affect the wool, which is an animal fiber.

Blending. — The various fibers are now blended for uses in different kinds of cloth; and this process is one of the most important in woolen manufacture, as the color, strength and style are determined here and therefore the price. The various fibers are weighed out, oiled with specially prepared oil, and laid on the floor in layers. The layers are piled alternately until the blend is complete. If shoddy, mungo, coarse wools, pulled wool or cotton are to be used in the blend, they are added here. Cotton is never oiled. Ability and experience are required to mix wools well and a successful blender has many cherished recipes. Samples of different wools are experimented with, and the percentages of various wools are carefully weighed. The blending does not in any way change the character of the fibers, as each one remains complete in itself, but they are so evenly mixed as to produce a perfect thread which combines the properties of each fiber. After oiling and blending, the processes for woolens and worsteds diverge.

Distinction between woolens and worsteds. — The division of wool fabrics into woolens and worsteds may be traced back to the immigration of the Flemish into England during the reign of Henry I, when they began the manufacture of worsted at Worsted. The Flemish combed the wool as well as carded it, and thus produced a smoother and more solid thread. The main difference between woolens and worsteds is that woolens are made from yarns in which the fibers are crossed and intermingled with no attempt to make them run in the same direction, while worsteds are made from yarns that have been combed out so as to make the fiber run in parallel directions. Up to some years ago a distinction was made between carding wools and combing wools, the former being the short wools used for wool; and the combing wools, the long wools, used for worsted; but this distinction is no longer made and both kinds of wools are now combed and used for both materials. Usually, however, the fine long wools go into the manufacture of worsted. The processes in the treatment of both are alike until after the oiling and blending. The machines are sometimes much alike, but the treatment is slightly different. Both woolens and worsteds are carded, but as the yarn for worsteds is also combed, the carding process for worsteds is less important than for wool. There are fewer processes in woolens than in worsteds. The names of these various processes vary sometimes in different parts of the world and for different types of materials. In the following discussion the fewest technical terms possible will be used.

Preparation of yarn. — *Carding.* — (*a*) *For wool.* — The carding of wool is similar to the carding of cotton as described in Chapter IV. The blended wool is put into the hoppers of a carding machine from which it is sent to carding cylinders covered with fine teeth which comb the wool into a fine film or sheet. After going through a second and

sometimes a third carding machine, the wool emerges in a rope-like " sliver " ready for the spinning machines.

(*b*) *For worsteds.* — Worsted carders differ from woolen carders in the following ways: they are slower on account of the length of the wool; in the doffing the fibers must be kept parallel, and in the preparation of the sliver for the next process. In carding worsteds care is taken to keep the fibers as much as possible in one direction and all the processes for worsteds have straightening the fibers as an object. If the yarn is to be a woolen yarn, it goes directly from the carders to the spinning mule. If the yarn is to be a worsted yarn, it goes to several other machines before spinning. A process commonly used for long wools is " gilling." This is carried on by means of gill boxes in which the wool is doubled and drawn out into slivers and slightly combed to make them more and more parallel. Four of these slivers are rolled up in a ball and the balls taken to a combing machine.

Combing. — *For worsteds.* — The wool sliver, although level and fairly parallel, contains short, curly fibers mixed with the long ones. The object of combing is to remove these short fibers and further straighten the remaining ones. This is done usually in this country on a " Noble " comb (see Fig. 58), a most interesting machine circular in shape. Eighteen balls of the prepared slivers are placed in regular order around the comb, four slivers coming from each ball; the ends of the slivers are attached to a combing apparatus and the wool is combed into a fine, silky strand still called a sliver. This is wound into a big ball and called a top. Many woolen mills produce tops as a product and sell to the other mills where cloth is manufactured. The waste material that is combed out of the wool in the combing process is called " noils " and is used in many ways which will be described later.

Further gilling and drawing. — For worsteds. — The wool is now sent through two or more gill boxes in order to blend the fibers more carefully, to comb the yarn again and to reduce the strands to uniform size. The strands are then

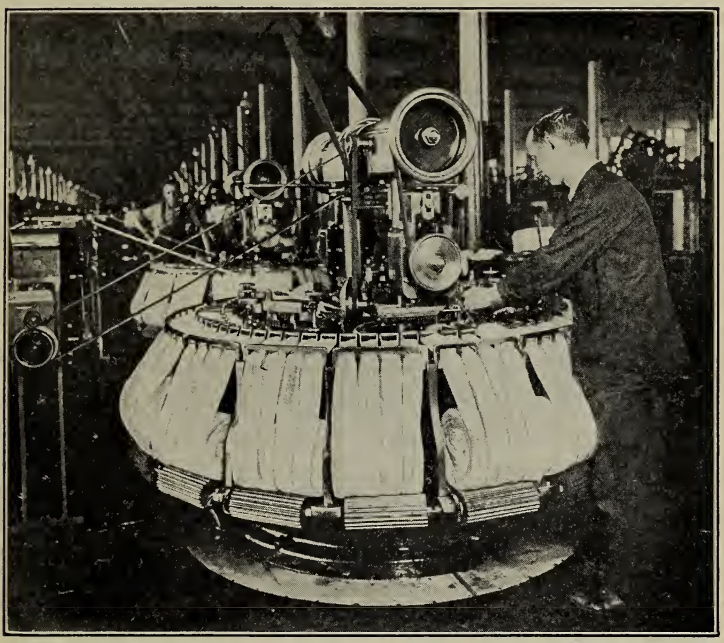


FIG. 58. — NOBLE COMB.
Used in combing wool for fine worsted materials.

again wound into balls and called "finished tops." This sliver, or tops, must be reduced to a size small enough to spin, and this is done by drawing machines which change the wool from the tops to *roving*. In the last stages of this process a little twist is added to give the yarn greater strength. The product from these machines is wound on bobbins.

Spinning. — (*a*) *For worsteds.* — The spinning of worsted is done either by the Bradford or English system, or by the French system. In the English system the wool is oiled before combing, but the French spin dry. The shrinkage is less in the French system and the yarn is fuzzier owing to the absence of oil. The chief difference is in the drawing and spinning and the amount of twist used. The French product is a soft, fine yarn used for fine dress and knit goods. English yarns are used more for hand-woven fabrics. The fiber is reduced to a twisted thread, about fifteen turns being made to an inch. Both the ring frame and the mule spinning machines are used, according to the finished product desired.

(*b*) *For woolens.* — The woolen yarns are usually spun on mule frames. (See Chapter II.) The sliver is drawn out into a roving which is soft and slightly twisted, with the wool fibers running in all directions. The mule draws this still smaller, puts in more twist, and sends it from the machines wound on bobbins.

Weaving. — The process of weaving is the same for both woolens and worsteds (Chapter II). The yarn is sometimes sized before weaving, the object being to strengthen the yarn and keep it from roughing up. Various substances, such as Irish moss, starch, glue and mucilage, are used. Inferior yarns are usually sized a good deal. The weaves may be plain, twill, double, pile or figured (Chapter II).

Finishing processes. — The beauty of woolen goods lies largely in the finishing processes; when taken from the looms they are coarse, rough and dull looking, and are far from attractive. On the other hand, worsted materials, after weaving, look much as in the finished state, as their beauty depends on the weave. Both are finished in a variety of ways. The cloth is first inspected for flaws,

broken threads or weak places, and where these are found they are mended and knots or bunches of threads are removed. This is called *burling*. The burlers or menders are usually women. After this the cloth needs to be thoroughly washed to remove the oil and dirt gathered in the mills.

Dyeing. — The dyeing of wool may be done either in the raw state after carbonizing, giving rise to the old-fashioned term "dyed in the wool"; in the "slub," after carding and combing; in the skein of spun yarn; or in the cloth after weaving. The last is called "piece dyeing."

Fulling. — One of the chief characteristics of wool, as has been stated, is its power of felting. In the fulling of woolens the object is to make the fiber felt together, which causes the cloth to shrink and become stronger and firmer in body. This process is characteristic of the wool industry. The selvages of the material are first sewed together with the face inside. The cloth is soaked in hot, soapy water and then run between heavy rollers which cause it to shrink in width. It enters a sort of box in a folded condition which causes it to shrink in length, and this process is continued until the desired condition is obtained. Both woolens and worsteds are fulled, but woolens are fulled to a much greater extent than worsteds.

Addition of flocks. — During the fulling process finely cut up wool waste called flocks is sometimes added and felted into the cloth. A layer of these short fibers is applied to the back of the material and these sink into the fabric and fill up the cavities. Flocks made of good stock are not detrimental, but if made from shoddy or mungo and used simply to cover up defects they are apt to shake out when the fabric is worn. It is not unusual and is not considered an adulteration to add 25 per cent in weight to the fabric by the use of flocks.

Napping or teazling. — The lustrous, soft pile of broadcloth and similar materials is made by roughing up the surface to raise a nap and then shearing it. There are two systems, the wet and dry. In the former the cloth is treated wet and in the latter dry. The best means of raising the nap is by the teazle (see Fig. 59), a vegetable growth something like the thistle. These are placed in parallel rows lengthwise on a cylinder which passes over the cloth several times and raises a nap, in some materials of sufficient depth to cover up the weave. No invention has yet been made which equals the use of the natural teazle, although an arrangement of wires is used for cheap fabrics. Some fabrics require more napping than others. Worsted suitings are napped just enough to bring out the weave and brushes are sometimes used instead of teazles.

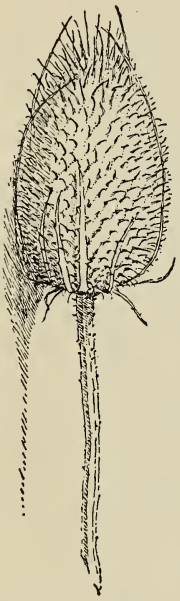


Fig. 59. — Teazle.

Shearing or cropping. — A shearing machine removes the uneven fibers on the surface of the goods by first brushing the nap all in one direction and then shearing it off evenly. This must be carefully done or the knives will cut the fabric. The fluffy croppings which are sheared off are used as flocks.

Pressing and other finishing processes. — Various processes, such as steam lustering, pressing and brushing, follow in the finishing process for both woolens and worsteds in order to bring out the luster of the wool. Poor wool will not give a good luster and must be given a surface finish. Starches, gums and chemicals are added which soon wear

off. After the steaming, which brings out the natural beauty of the wool, the fabric is tentered or stretched and subjected to heavy pressure, and sometimes is passed through a calender. An important treatment is spraying with water in order to prevent spotting and shrinking. A common finish now is passing the goods between heavy rollers heated by steam. Some worsted goods are treated in other ways. Singeing or gassing is sometimes employed on goods where a smooth finish is desired. A sanding machine is often used in which emery-covered rollers produce a clear surface. New varieties of goods and new processes are being introduced constantly. The finished cloth is inspected, measured, doubled, rolled and packed ready for shipping.

Summary of Distinctions between Woolens and Worsteds

1. In yarn for worsteds the fibers lie parallel; in yarn for woolens the fibers cross and are matted and intermixed.
2. Wool for woolens is carded only, while for worsteds it is carded and combed.
3. A worsted thread is fine, even and wiry, while a woolen thread is uneven and irregular.
4. In the finishing processes the woolens are fulled and allowed to shrink more than the worsteds. The teazling and napping processes are carried further.
5. In the finished material the worsted fabric has a clear, bright, well-defined weave, close, firm and well woven; while a woolen fabric is softer and the weave is not so easily distinguished.
6. The types of machinery used are slightly different and both industries are not usually carried on in the same mill.

Use of wool substitutes. — *Shoddy.* — The ever increasing demand for a cheaper class of cloth has made it quite impossible to employ pure wool to any large extent in its production, and a number of substitutes are in general use. Shoddy and mungo are probably used more than any other

substitutes and have been used since the first part of the nineteenth century. As has been stated, they are the manufactured product of worn garments, stockings, blankets, sweaters, dress goods and pieces of new wool cloth which are wasted from factories. Rags of the material are gathered from all parts of the country and go first through the operation known as dusting. A machine designated as a " devil " shakes out all dust and loose matter from the rags, leaving them ready for the sorters, who place them in separate classes according to color, quality and fiber (all wool or mixed with cotton). The rags are now ready for the grinding machines, which not only tear fiber from fiber but reduce the material to a fluffy state somewhat resembling colored cotton wool. This is now ready to blend with other wools and the amount desired is added during the blending process. The use of shoddy is not to be condemned, but it should not be sold as pure, good wool. It is used largely in knit goods.

Extracts. — Rags containing cotton are put through a process known as carbonizing, in which the rags are treated with an acid which destroys the vegetable matter, or cotton. They are then washed, dried, ground up and sorted. This wool is called *extract.*

Flocks. — Flocks are the soft fluffy fibers discarded in some of the processes of woolen manufacturing, usually during the shearing. They are short, fine fibers and are sometimes called pulverized wool. They are added to wool in the fulling process (see page 137) and are also used in the manufacture of wall paper.

Noils. — The noils, as stated above, are the wool fibers remaining in the comb after the process of combing. Manufacturers of woolen goods use noils for dress goods and blankets, but worsted spinners cannot use them to any extent.

Use of cotton. — A great deal of cotton is used in both the woolen and worsted industries. It is used as either warp or filling, or is mixed with wool in making mixed yarns. The presence of cotton may always be detected, but it is more difficult to detect the presence of shoddy. (See Chapter VIII.) The use of cotton in knit goods has given a great impetus to the manufacture of woolen knit goods. Cotton and wool are mixed together to lessen the shrinkage of the wool.

Finished products. — *Yard goods.* — Dress goods made from wool come under the head of woolens and worsteds, although it is not always easy to classify the new fabrics which are constantly coming into fashion. Among the best woolen fabrics are broadcloth, homespun, melton, kersey, tweed, cheviots and cashmere. Worsted fabrics include serges, gabardine, whip cord, diagonals, voile, panama, etc. Material has been made with a worsted thread used as warp and a woolen thread used as filling. The use of worsted fabrics has been increasing in recent years and much more wool is made into worsteds than into woolens. They partake at times of opposite characteristics because of variations in finish. A number of new woolen materials have come into fashion recently — duvetyn, kitten's ear, wool velour, Bolivia cloth, etc. The brilliantines, mohairs and alpacas so much in vogue at certain periods are made with a cotton warp and a mohair filling. The table at the end of the chapter may be consulted for facts about materials.

Carpets. — The products of carpet manufacture divide themselves into pile carpets and carpets with a flat surface. Pile carpets are made as cut pile and uncut pile. Brussels carpets are uncut pile in which the loops are not cut and in which three sets of warp are used. The main warp, or body part, is made of flax, hemp or jute; the second set of warp consists of the colored wools which show as foundation in

the weave; and the third set are the wools that are drawn up into loops by being made to pass over wires. A tapestry Brussels is a cheaper substitute made with one warp and woof. Of the cut pile carpets, the Axminster and Wilton are the best, and the Wilton and Velvet are most in use. The Axminster is woven like Turkish carpets with bunches of colored wool tied in the warp and then sheared; the Wilton and the Velvet are made like the Brussels but with the loops cut. Ingrain carpets are woven like cloth on a Jacquard loom with a two-ply or three-ply yarn. They are sometimes made with worsted in both warp and woof and are found in all qualities and prices. The Kidderminster carpet is a Scotch ingrain with woolen warp and worsted woof.

Oriental rugs. — Years of study have been devoted to oriental rugs, and it is not possible more than to touch upon the subject in one paragraph. The first rug was probably woven many thousands of years ago, and both Egypt and Babylon claim the honor of being its birthplace. During the sixteenth century rugs were carried into England, and for a long time they could be found in Europe in the cathedrals only. Rug making is still the principal industry in Persia and in many parts of Turkey. These rugs are desirable because of the excellent material used in both fabric and dye, both of which are produced among the hills of these countries. The wool of the sheep and lambs is used for the pile of the rug and goat's hair for the warp. The method of weaving is the same to-day as it was thousands of years ago. The warp is stretched first and then the pile is made by knotting in pieces of wool cut into short lengths. Special patterns and colors are favored by different nationalities. Turkish rugs are prevailingly red, Persian green, and Armenian blue. These beautiful colors are produced from natural vegetable dyes. Oriental rugs may be divided into four groups: Persian, Turkoman, Caucasian and

Turkish. These are again renamed from the district from which they come. A prayer rug has a prayer pattern woven at one end, the other end being entirely different. Valuable rugs are often injured because of careless cleaning. They should rarely be beaten, but gently tapped with a flexible beater and then swept hard on both sides. Care must be taken to keep them free from moths. The Chinese rug has been much used in recent years; it is usually of a delicate coloring of light tans and blues. Navajo rugs or blankets are made by hand by the Navajo Indians in New Mexico and Arizona. Genuine ones have both sides exactly alike and the better grades are made of hand-spun wool.

CARPETS AND RUGS

ARTICLE	SIZE	COST
Real oriental rug	4 ft.×6 ft.	$ 35 up
Navajo rug	5 ft.×10 ft.	18 up
Chinese rug, genuine	9 ft.×12 ft.	250 up

CARPETS

Axminster	27 in. wide	$3.50 yd.
Wilton	27 in. wide	3.25 yd.
Velvet	27 in. wide	1.85 yd.
Brussels, body	27 in. wide	2.50–3.50
Ingrain	27 in. wide	1.25

Domestic rugs are constructed on specially adapted looms to imitate the handmade. The original Wilton rugs were, and are still, made by hand in England on upright looms. They are of great beauty and are high in price. The machine-made Wilton is a copy and is an excellent article at a lower price. Rugs are used now much more than carpets

and may be purchased woven in patterns or made up from carpet materials. Wilton and Axminster carpets are woven on a wide loom and are made without seam in several differing widths. Chenille Axminster may be purchased in many plain colors from $12 to $18 a square yard, as wide as thirty feet. Wiltons are from $7.50 to $8.50 a square yard and come 12 feet wide.

Fig. 60. — Weaving of Gobelin Tapestry.

Tapestries. — The art of working tapestry with the needle was known at a very early date and was used until mechanical weaving was introduced in the nineteenth century in France and a manufactory established at the Abbey of St. Florian. The process differs from ordinary weaving in that the thread runs from selvage to selvage, but each small part of the design is woven separately. In early times tapestry was used mainly for altar cloths and other church decorations but its growing use as wall and furniture coverings resulted in the establishment of looms at Antwerp, Bruges and other cities. The tapestry made at Arras was the most famous. During the time of Louis XIV the famous Gobelin workshops in Paris were reorganized and Gobelin

tapestries were manufactured for royalty alone. The old tapestries are of great value, and museums contain many beautiful specimens. Besides the Gobelin and Aubusson works of France where beautiful tapestries are made at the present time, tapestries are made at the Merton Works in England and at the Herter studios, New York.

Blankets. — Blankets are usually spoken of as all wool, but probably three out of four of the medium-priced blankets on the market are made with cotton warp. Blankets may be purchased either folded double or in a single piece, and for single, three-quarters or double beds. The best blankets have a surface resembling a rather thick bed of wool and are light as well as warm. Many of the expensive all wool blankets are now bound separately. The average price paid for blankets is about $7 for a double blanket, but this is made on a cotton warp. Good all wool double blankets cost from $18.50 to $30 a pair. Prices of wool materials have advanced at a tremendous rate since the beginning of the present war.

YARNS

NAME	SKEIN OR BALL	PRICE
Good Shepherd		
Shetland	ball	$ .50 ball
Vicuna	ball	.55 ball
Cygnet	ball	.55 ball
Knitting yarn	ball	.35 ball
Utopia	8 hanks to box	2.35 box
Knitting yarn	hank	.75
Fleischer yarn	hank (4 hanks to lb.)	2.00 lb.
Saxony	hank	.18 skein
Lady Grey	hank	.25 skein
Germantown	hank	.30 skein
Amoskeag	hank (4 hanks to lb.)	2.50 lb.

Yarn. — There has recently been a revival of interest in knitting, and much woolen yarn has been manufactured to meet the demand for handmade sweaters and other knitted garments for the use of soldiers and sailors and war sufferers. The preceding table gives the names and cost of some of the important brands.

Knit goods. — Large quantities of wool and worsted yarns are used for knitted goods, including cardigan jackets, sweaters, hosiery, gloves, mittens and underwear. Cotton is used largely in combination with wool and produces a fabric that does not shrink and which is in some ways more desirable for underwear. See Chapter II on knitting.

QUESTIONS

1. In what way is the wool fiber different from the cotton or flax fiber?
2. What is the reason for the great shrinkage of woolen materials?
3. What distinction would you make between the use as a textile fabric of the wool of sheep and the hair of the goat?
4. To what extent does the care of the sheep influence the wool fiber?
5. What is the difference between "fleece wool" and "pulled wool"?
6. How are different grades of wools used in the making of one fabric? To what extent is blending important?
7. Give four distinctions between woolens and worsteds.
8. How important is the fulling process in the making of a piece of flannel?
9. Why does the weave show but slightly on a piece of broadcloth and show plainly on a piece of serge?
10. What would you be apt to find besides pure fleece wool in a piece of serge sold at 75 cents a yard?
11. How valuable an industry is the rag industry and what connection has it with the woolen trade?
12. How is flocks used in the manufacture of cheap broadcloth?

Questions and Problems for Further Study

1. To what extent has the world war influenced the woolen industry in the United States?
2. Compare the treatment during manufacture of a piece of serge costing about $3.50 a yard and a piece of Bolivia cloth at $6.00.
3. To what extent and for what purposes is "carpet wool" used in the United States?
4. How would you explain the following advertisement: "Knitting yarn made from best quality worsted"? How may a knowledge of textiles be utilized in writing advertisements?
5. What is meant by a "Pure Textile Law" and how valuable would such a law be?

WOOL

Name	Price	Width	Weave
Albatross	85¢	44″	Plain
Alpaca	$1.25–$2.00	44″	Plain
Astrachan	$4.50–$6.00	52″	Pile
Basket Cloth	$1.50–$2.50	44″	Basket
Bedford Cord	$1.75	45″	Plain, corded
Bolivia Cloth	$3.00–$6.00	54″	Pile
Brilliantine	$1.25–$2.00	44″–54″	Plain
Broadcloth	$2.50–$5.00	54″	Twill
Chiffon Broadcloth, a lighter weight			
Bunting	45¢–60¢	24″	Plain
Cashmere	$1.25–$1.50	42″	Twill
Challie	80¢	27″	Plain
Cheviot	$1.50–$3.00	50″	Twill
Chinchilla	$3.00–$5.00	54″	Pile
Covert Cloth	$2.00–$4.00	54″	Twill
Cravenette	$2.50–$3.50	54″	Twill
Crepon	$1.50–$2.00	54″	Plain
Diagonal	$1.50–$2.50	50″–54″	Twill
Eolienne	$2.00	44″–50″	Plain

MATERIALS

Character	Use	Wearing Quality
Plain faced, soft, fine wool, like crêpe	Light-weight dresses	Good
Smooth, glossy, mohair woof and cotton warp	Dresses, coats, petticoats	Excellent, sheds dust easily
Heavy fabric, cotton base and surface of mohair woven to imitate curled hair of Astrachan sheep	Coats	Good
Cloth woven with pattern like baskets. Loose weave	Suits, dresses	Fair
Heavy ribs running lengthwise	Dresses, suits	Good
Heavy, velvet-like, soft, woolen material	Coats	Fair
Glossy, hard surface, like alpaca	Suits, dresses, petticoats	Excellent
High-grade woolen cloth, slightly napped and glossed	Suits, dresses	Good
Soft, light, plain cloth. White and colors	Flags	Good
Fine, soft finish. Fine qualities from hair of Cashmere goat. Dyed in plain colors. Woolen	Dresses	Excellent
Light-weight fabric. Pattern printed on one side	Light-weight dresses	Excellent
Rough-finished surface. Like serge but heavier. So-called from shaggy wool of Cheviot sheep	Coats, suits	Excellent for hard wear
Heavy, strong, woolen cloth with rubbed or tufted surface	Boys' overcoats	Excellent
Cloth of tan, mottled appearance produced by particolored threads	Overcoats, riding suits	Wears excellently
Material similar to serge, rendered waterproof	Coats, suits	Excellent
Fabric with crinkled or crêpe surface	Dresses	Good
Fabric so woven that distinct lines run diagonally across surface. Like cheviot	Suits, coats	Excellent
Silk warp, worsted filling. Lustrous, soft material	Dresses	Good

WOOL

Name	Price	Width	Weave
Etamine	$1.75–$3.50	42″	Plain
Flannel	85¢–$1.50	27″–36″	Plain or twill
Felt	$2.00	2 yd.	Felted
Gabardine	$1.50–$3.00	48″–54″	Twill
Gloria	75¢ up	50″	Twill or plain
Grenadine	$2.00	48″	Gauze
Granite Cloth	$1.00	42″	Plain
Henrietta	$1.25–$2.50	42″–48″	Twill
Homespun	$2.00–$3.00	50″–54″	Plain
Hop Sacking	$2.00 up	50″–54″	Plain
Jersey Cloth	$3.00–$5.00	54″	Knitted
Ladies' Cloth	$2.25–$3.50	54″	Plain
Melton	$2.50–$4.50	57″	Plain
Mohair — See Brillian-tine			
Nun's Veiling	$1.25–$2.00	42″	Plain
Panama	$1.25–$2.00	42″–54″	Plain
Polo Cloth	$3.50	54″	Double
Poplin	$1.25–$2.50	42″–54″	Plain, cord

MATERIALS — *Cont.*

Character	Use	Wearing Quality
Rather open weave woolen goods, somewhat transparent	Dresses	Fair
Loosely woven woolen material with nap surface. White and colors	Petticoats, waists, shirts	Excellent, very warm
Heavy cloth formed by felting fiber with moisture, heat and pressure	Table covers, pennants, banners	Excellent
Soft, firm material like whip cord	Suits, coats	Excellent, not shiny as quickly as serge
Soft material, silk and wool, or silk and cotton	Umbrellas	Excellent
Thin material, open weave, made in cotton, silk and wool	Dresses	Excellent
Granite-like surface, irregular weave, worsted material	Children's dresses	Excellent
Fine material like finely finished cashmere	Dresses	Excellent
Rough material, either handmade or made to imitate handmade goods. Loosely woven	Dresses, suits	Excellent
Coarse, rough, loose weave like bagging	Suits and skirts	Fair, apt to pull
Knitted stockinet. Made also in silk	Dresses, suits	Excellent but loses shape
Dress flannel with broadcloth finish	Dresses, suits	Fair, loses luster
Heavy, smooth cloth, well fulled, short nap. Named for Melton, England	Overcoats	Excellent
Light-weight, soft material. Standard fabric. All colors	Dresses	Excellent
Hard thread, plain worsted goods	Dresses, skirts, suits	Excellent, very serviceable
Heavy golf cloth, double faced	Capes, coats	Excellent
Repped fabric, made in silk, wool and cotton. Filling is heavier than warp	Dresses	Good wear

WOOL

Name	Price	Width	Weave
Prunella	$1.25–$2.50	42″–54″	Twill
Serge	$1.50–$3.50	45″–54″	Twill
Shepherd's Plaid	$1.50–$2.50	45″	Plain or twill
Tweed	$2.00–$3.00	54″	Plain or twill
Tricotine	$4.00–$7.50	48″–56″	Twill
Venetian Cloth	$2.00–$3.00	50″–54″	Twill
Velour	$3.00–$7.50	54″	Pile
Voile	$1.50–$2.50	44″	Plain
Whip Cord	$1.50–$2.60	44″–54″	Twill
Zibeline	$2.50–$4.00	54″	Twill

MATERIALS — *Cont.*

Character	Use	Wearing Quality
Strong, twill-faced, woolen cloth, glossy surface	Skirts, dresses	Good
Hard or soft finished worsted material. Plain colors	Dresses, suits	Excellent, wears shiny
Small, even check in black and white	Dresses, suits, coats	Excellent
Soft, rough, coarse cloth, open texture	Suitings	Serviceable
Like gabardine, but woven with a double twill	Suits	Wears well
Woven with rounded twill. Soft material like broadcloth	Coats, suits	Good
Velvet-like, soft material, made several styles. Cashmere velour, made from Cashmere goat hair. Diagonal velour has diagonal lines running across. Wool velour, made from woolen yarn	Coats, suits	Good
Worsted material woven in open weave	Dresses	Good
Raised twill or cord running diagonally across face	Suits, skirts	Excellent
Loosely woven; glossy surface, long hairs on surface	Suits	Good

CHAPTER VII

SILK

A. Natural Silk

Early history of silk culture
Present status
Life of the silkworm
Wild silks
Raw silk
    Reeling
    Conditioning
Processes of manufacture
    Throwing
    Degumming
    Bleaching
    Dyeing
    Printing
    Weaving
    Finishing
Waste silk
    Manufacture
    Uses
Finished products
    Yard goods
    Knit goods
    Underclothing
    Ribbons
    Silk threads
    Miscellaneous

B. Artificial Silk

Varieties
    Nitrocellulose silk
    Cuprammonium silk

Natural Silk

Early history of silk culture. — As far back as the time of Noah, the Chinese were rearing silkworms and weaving silken garments. The origin of sericulture is credited to the Empress Si-ling-chi, the "Goddess of the Silkworm," who learned to rear the worms and reel the silk from the cocoons. This knowledge was considered so precious in China that it was a jealously guarded secret within the kingdom, and to take the silkworm eggs out of the country was punishable by death. Indeed it was two or three thousand years, long after silk was used in other countries, before its origin became generally known. Two monks are supposed to have been the direct cause of the spread of the silk industry. They smuggled some eggs to the Emperor Justinian in the hollow of their bamboo staffs. So from that time, 55 A.D., silk raising began to work its way through the Mediterranean countries — to Greece and Syria, to Spain with the Moors, and finally to Italy and France. In these last two countries it gained a foothold out of which, through six or seven centuries, has grown a leading industry.

In America, the early colonists gave some attention to rearing silkworms, especially in Georgia. A good quality of silk was produced, but the quantity was not sufficient for home consumption, and by the time of the Revolution a large amount of silk was being imported. In the latter part of the eighteenth century silk raising was introduced into Connecticut, and in 1810 the first silk mill in America was established at Mansfield, Connecticut. A few years later

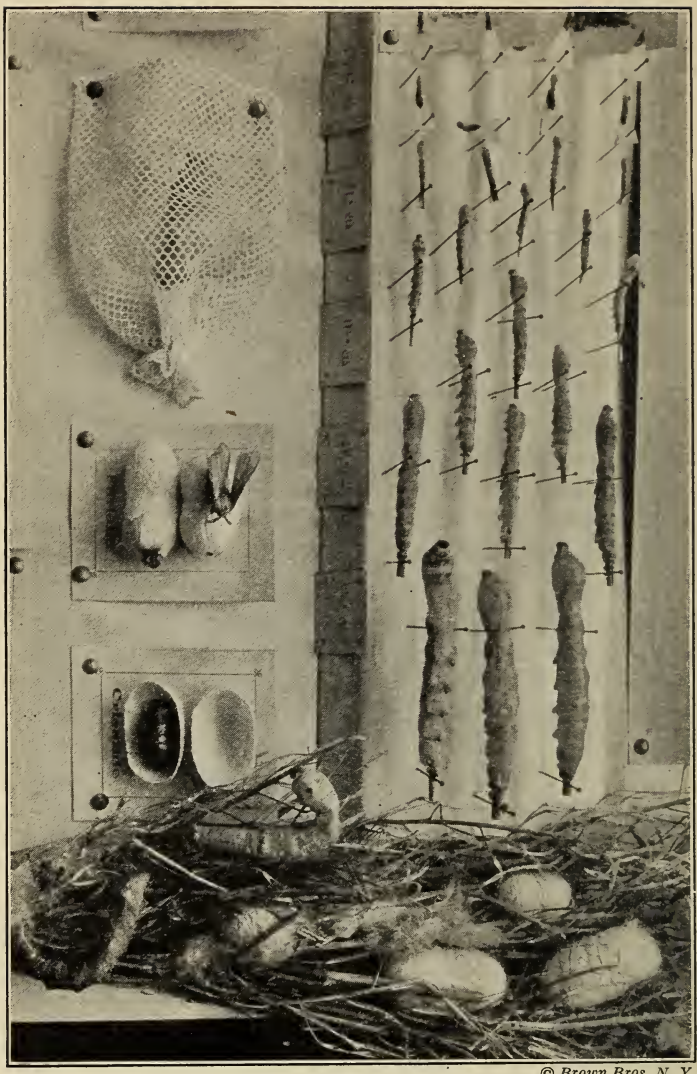


FIG. 61.—SILK MOTH, CATERPILLAR AND COCOON.

a sudden enthusiasm for sericulture swept over New England; speculators invested fortunes in the business and lost them, for there came a blight on the mulberry trees, which put an end to the enterprise. In recent years, where it has been attempted in various parts of the country, it has not achieved great success, partly because in an industry where so much hand work is required, Western labor cannot compete with European or Oriental.

Present status. — China, Japan, Italy and France lead in the production of raw silk. The north of Europe manufactures rather than produces silk, and the United States imports and manufactures more silk than any other country. Paterson, New Jersey, is the chief silk manufacturing city in the United States.

Life of the silkworm. — Many species of caterpillars produce silk. Some live in the open, feed mostly on the scrub oak, and make a variety known as wild silk. The species from which most of the silk of commerce comes is the domesticated caterpillar, *Bombyx mori*, which is reared in cocooneries and feeds on the mulberry.

This caterpillar, when it hatches from the egg, is a tiny creature about as large as the head of a pin, with a voracious appetite for mulberry leaves. Its appetite and its growth are commensurate, for in its short life of a month it increases its length at least thirty times and its weight perhaps ten thousand times. To allow for this rapid growth it puts on a new and larger skin four times. This change of skin is called molting. When it reaches maturity it is about three inches long, a velvety white worm with nine breathing pores that look like black spots down each side of its body. Now it stops eating, and the restless lifting of its head shows it is ready to spin. When brush or twigs are provided it throws out fastening threads and begins its cocoon. The thread that forms the cocoon comes out of

FIG. 62. — MOTH LAYING EGGS.

an opening near its mouth, and is really two filaments held together by a gummy coating. Back and forth it throws this thread in a figure eight, until three days later the worm has inclosed itself and is changing into a chrysalis.

After fifteen or twenty days the chrysalis is ready to come out as a moth. It may not be allowed to do this, for the silk of a cocoon is broken if the moth emerges, and is lessened in value. Most of the cocoons are heated to kill the chrysalis; only those moths are allowed to emerge which are intended for reproduction. The moth is cream-white, and about an inch long. Only three days of life remain to it; in that time the female moves very little, and lays several hundred eggs.

The eggs are so small that it takes about forty thousand to make an ounce. They are laid on cloths, which are kept in a warm place for several days, then put in cold storage for six months, or until the season of mulberry leafage returns. Again they are put in a warm room and incubated, at about 75 degrees. In twenty or thirty days the tiny caterpillars come out. The cocooneries in which the worms are reared are clean, well ventilated, roomy and quiet, for the silkworm is a difficult creature to rear, sensitive to noise, and subject to disease.

Wild silks. — Many species of caterpillars, other than the *Bombyx mori*, spin a cocoon from which a silken filament can be reeled. They are found in most countries of the world, but the best wild silk is gathered in Japan, China and India. The name Tussah or Tussur has been given to the Indian variety, but it is also used to include all wild silks. The food of these caterpillars that live in the open is seldom the mulberry, but often the oak, and the cocoons are placed in the trees, from which they are collected with considerable labor and expense. Owing to differences in species of the caterpillars, and the food they eat, wild silk

FIG. 63. — HAND REELING.

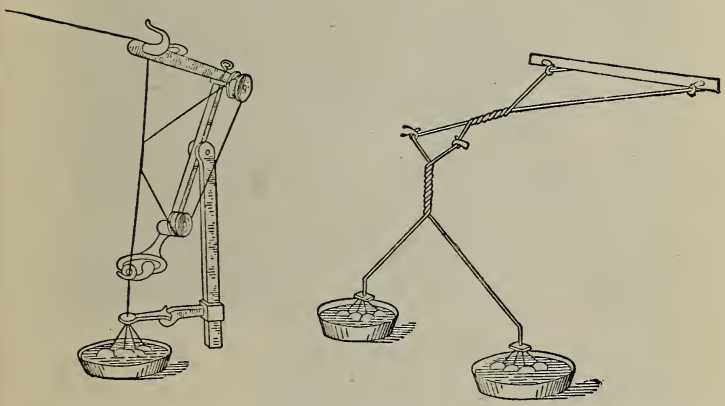
At the left are trays of brush to which the cocoons are attached.

is seldom as light in color as the cultivated, usually varying from cream to dark brown. As it is difficult to bleach and dye, it is used in its natural shades for pongees and shantungs. Pile fabrics, such as velvet and plush, are often woven of wild silk.

The wild silk fiber is rougher and coarser than the cultivated. It makes a fabric of uneven texture, but generally of good strength.

Raw silk. — Cocoon silk of whatever kind, before it is altered by manufacturing processes, is called raw. The first step in silk preparation is unwinding from the cocoons, or reeling.

Reeling. — Reeling is still done by hand in some primitive districts, particularly in China, but the work is not so even as that of the steam reels or filatures.



From Matthews' "Textile Fibers," *by courtesy of John Wiley & Sons*

FIG. 64. — CROISSURES.

The reeler soaks the cocoons in hot water to soften the gum, and removes the loose outer mass of threads. Then, taking a brush, he moves it over the surface of the cocoons

until he finds the long continuous filaments from as many cocoons, generally three or four, as he wishes to unite in a single thread, and carries these up through a ring or guide. Just beyond the guide, this group meets a similar group from another set of cocoons, and the two are made to twist round

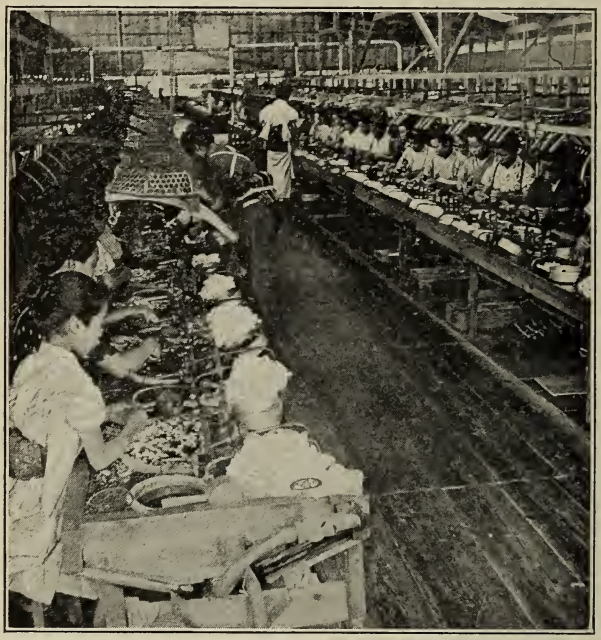


Fig. 65. — Modern Method of Softening and Reeling Silk from Cocoons.

each other for a few turns before separating and passing on to be wound on the reels. This and similar twisting devices, called croissures, are designed to smooth and straighten the filaments, and cause those of each set to cohere more closely. Finally, in the winding on the reels, this cohesion

is made more perfect, as the softened gum is now hardening and holding the four or more filaments in one homogeneous thread.

Reeling is a process which requires much skill, in order to produce a smooth, even and clean thread. As a rule, better reeling is done in Europe than in Asia, although Japan sends out a good grade of reeled silk. Reeled silk is sold in hanks as raw silk, and is advancing in price at the present time. The probabilities are that it may double its former selling price, and reach about $8 per pound.

Conditioning. — Raw silk has a great avidity for moisture, and will absorb 30 per cent of its weight without appearing moist. As it is bought and sold by the pound, this weight of water is a consideration. Buyers in this country require that the amount of excess moisture in raw silk be removed. This

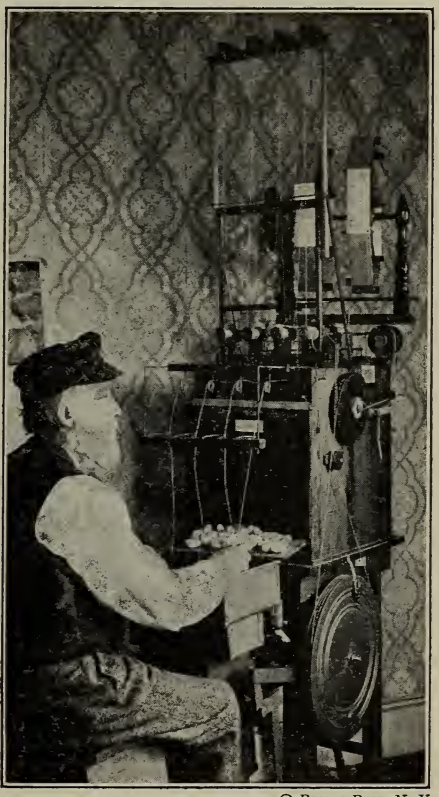


Fig. 66. — A Form of Silk Reeler which Reels the Silk Directly on Spools.

is done by silk conditioning houses. The skeins of silk are thoroughly dried in desiccators, weighed, and an allowance of 11 per cent for a normal amount of moisture is added. The resulting weight is the basis for purchase.

Processes of manufacture. — The manufacture of silk begins in the United States with the imported reeled silk; very little silk is reeled in this country. Raw silk from the reels is not ready to be woven immediately into fabrics; it is harsh, stiff and lusterless because of its coating of gum, and for certain purposes its threads need to be twisted to make them stronger, and to keep them from separating in the dye bath.

Throwing. — The processes which convert the reeled silk into yarn or thread are called *throwing*. It is practically analogous to spinning. When the silk reaches the throwster it is weighed and examined. If the gum is to be softened, as is usual, the silk is soaked for some hours in warm soapy or oily water. After drying, the skeins are put on reels in a winding frame and wound on large spools or bobbins. The filaments are freed from dirt and adhering particles by being made to pass from one bobbin to another between two parallel plates, set so closely that there is just room for the silk to pass through. It is now ready for the main processes of throwing.

The bobbins are now placed in a doubling frame. Doubling means bringing together as many single threads of silk as are required to make a thread of a given size. It is accomplished by carrying the threads from several bobbins through a guide and winding them on a single bobbin. The spinning machine then takes these collected threads and twists them. The amount of doubling and twisting depends upon the purpose for which the silk is designed. For example:

Single threads of raw silk wound on spools with little or

FIG. 67. — SILK DOUBLING.

no twist added are called *singles*. They are sometimes used for warp or filling in piece-dyed goods where the gum is removed after the silk is woven. The gum holds the untwisted filaments together in the weaving process, but if

dyed in the skein the threads would soften and separate in the dye bath. Cloth made from singles is soft and brilliant. Pongee is an example.

Combining two or more single reeled threads into a soft thread by a loose twist produces *tram*. It is used for filling yarns.

Organzine is designed for warp threads, and is usually stronger and of better quality than tram. A right-hand twist is given a group of three to eight single threads, and two or three of these groups are then firmly held by a left-hand twist.

A hard-twisted thread, either singles or tram, is used for crêpe and chiffon fabrics. Sewing silk, machine twist, and the different kinds of embroidery silk have each a definite combination of threads and twisting.

Degumming. — In the throwing process only a little, perhaps 2 or 3 per cent, of the silk gum has been removed by soaking. Thrown silk because of its gum is harsh, wiry, dull, and not adapted to taking dye well, nor weaving into soft, lustrous fabrics. The skeins are now placed in boiling soapy water and worked until the gum is dissolved and washed out. The process is sometimes called boiling off, or stripping.

If all the gum is removed, the scoured silk will have lost from 18 to 25 per cent of its original weight. Some silk is only partially stripped. Souple silk has about one-sixth of its gum removed; it is therefore less lustrous than if completely scoured, and is suitable for dull finished fabrics. Ecru silk has very little gum removed.

Bleaching. — Following degumming, silks intended to be pure white are bleached. Sulphur fumes and hydrogen and sodium peroxides are the bleaches commonly used. For example the operation may be carried out by soaking the skeins in hydrogen peroxide and ammonia for some hours, then washing.

Dyeing. — After degumming, dyeing is the next process for colored silks. Silk has a great affinity for dyestuffs, and also for solutions of metallic salts, such as the salts of tin, iron and chromium. These salts can be absorbed by the silk fiber in almost any amount. In the boiling off, there has been a shrinkage in weight of perhaps 25 per cent; for example, one hundred pounds of thrown silk may be only seventy-five pounds when it reaches the dyer. At a possible value of $5 to $10 per pound, this constitutes a serious loss. If the silk is to be pure dyed, it goes directly to the dye bath, but in most cases the dyer receives instructions to make up the loss in weight by adding weighting to the silk before dyeing. A certain amount of weighting, perhaps enough to bring up the silk to its original weight, is legitimate if it is of such a nature that it does not injure the silk, but gives it body and finish. However, the ease with which silk can be doubled or trebled in weight, and the demand for cheap imitations of expensive pure silks, have brought about the common practice of loading silks to the limit of their fiber endurance.

The tin salt known as stannic or tin chloride is most often used for weighting, as it can be combined with all colors. The silk is passed through a bath of tin chloride, one dip being equal to about two ounces of weighting on sixteen ounces of silk. After washing thoroughly, to fix the salt on the fiber and remove any free acid, it is placed in a solution of sodium phosphate, which prepares it for absorbing more of the tin salt. After washing, it is again dipped in the tin bath, from which it takes up more weight. Finally it may be treated with a silicate bath. These dippings and washings are repeated until the required weight is reached. For some purposes, such as the filling for cheap black grosgrains, twelve ounces of thrown silk may be delivered as forty ounces of dyed silk.

With the exception of black, the coal tar or artificial dyes are commonly used. The best black is produced on silk by the natural dyestuff logwood, fixed on the fiber by mordants of iron nitrate and tannin. A mordant is a substance which fixes the dye on the fiber by making a chemical combination with the two. The silk passes through the mordanting solutions, then into the logwood bath. While the silk is being mordanted, weight is added by absorption of the iron nitrate. Here tin is frequently added to increase the weight.

When excessive weighting is practiced, it is as a rule on dark-colored, stiff silks of the taffeta variety, and on silks dyed in the skein, although piece-dyed silks are now being weighted to some extent. Soft silks, such as foulard, liberty and crêpe de chine, seldom carry a large amount of weighting. While all metallic salts in excess cause an undue strain on the fiber by their sheer weight, salts of tin especially act as cutting edges when they crystallize, and the silk garment soon splits in its folds. The continued action of sunlight and perspiration both have a rotting effect on silk weighted with tin.

While it is difficult for the manufacturer to put a pure dyed or unweighted silk on the market in competition with the flood of cheaper weighted material, still the consumer who is willing to pay the price for the better article can generally find it. It is the demand for cheap silks that fosters the practice of weighting them. A sample of any silk bought by the yard can be tested for weighting by a simple method described in the next chapter, therefore the purchaser can protect herself against buying goods which are practically worthless because of excessive weighting.

Printing. — Printed silks are popular at present. Foulards, sport silks, and any other silk fabric having a design which is not structural, are printed. The three methods

in use for printing silk are the same as those described in the chapter on cotton.

After printing, the cloth is steamed to set the color, washed in large quantities of water to free it from excess dyestuff, and either dried or sent through finishing processes.

The clouded effect of Dresden ribbons is produced by printing the design on the warp threads before weaving.

Weaving. — Except for some special fabrics, the process of weaving silk is similar to that for other textiles. The warping is done by placing four or five hundred bobbins on a creel, and unwinding from this upon a warper reel. As many yards of silk are wound upon the reel as will be required to make the length of the finished piece — that is, from three to six hundred yards for dress materials. From the warper reel the silk is wound upon the warp beams, and the harness is threaded. Some special effects are produced in the following ways:

Brocades are made on the Jacquard loom. The pattern is given a raised surface on the right side of the goods.

Velvets and plushes are woven with long loops which are cut to make a pile nap.

Crêpe de chine has a plain weave, with the warp threads partly right and partly left twisted.

Bengaline, ottoman, grosgrain, poplin, Terry velvet, faille française and peau de soie use ribs and cords for their effect. Bengaline, for example, has filling cords of wool or cotton covered with the silk warp. Peau de soie is an all silk fabric with a very fine ribbed effect running filling ways.

Finishing. — The finishes given to silk are too varied and technical to be described in detail. Yarns may be soaked in dilute acid to give scroop and gloss, gassed to burn off protruding ends, wrung and stretched to soften, or stiffened with gums, starch or glue, a process called sizing. Cheap grades of silk are usually well sized. Some silks, such as

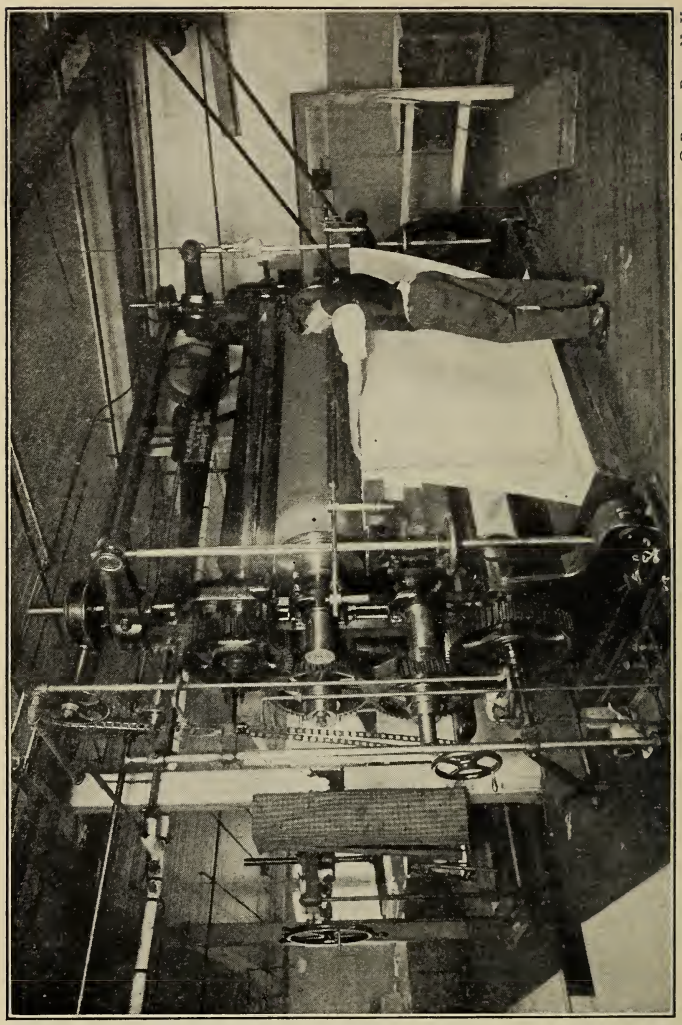


Fig. 68. — Finishing Silk Cloth.
One of the elaborate machines necessary in finishing silk.

grenadines, are saturated with sizing; some merely have their surface sprayed by a machine resembling an atomizer.

Woven silks may have special machine treatment. Steam cylinders dry and straighten them; breaking and rubbing machines soften them. Cheap thin silks become too flimsy if put through softening machines, but good firm cloths are improved. Metal rollers give a bright or soft finish, as desired; tentering machines stretch to uniform width; and many other general and special treatments are given. Velvets are steamed, and the luster of panne velvet is produced by pressing. The moiré finish is given by the uneven pressure of engraved rollers. Taffetas undergo numerous special finishes, including immersing in dilute acid to give scroop and luster, treatment to prevent spotting with water, and pressure under hot rollers.

Waste silk. — In the silk industry there is always a considerable part of the product which does not give long threads suitable for reeling. This is classed as waste silk, although it is not waste in the sense that it has no market value. A better term is spun silk, for the reason that the filaments have to be carded and spun like cotton before they can be woven. Waste silk comes from the following *sources:*

1. The tangled silk on the outside of the cocoon. This is called floss silk, and is of good quality.
2. The tough inner skin of the cocoon, left after reeling.
3. Imperfect cocoons, pierced by the emerging of the moth.
4. Wild silks that cannot be reeled to advantage.
5. Machine wastes from reeling, throwing and other processes.

Manufacture. — Silk waste goes to the manufacturer in bundles of cocoons or of loose threads, as the case may be. Before the threads can be opened up the gum must be re-

moved. This is sometimes done by putting the silk in open mesh bags and boiling in soapy water until the dissolved gum washes out through the bag. Another method, called schapping by the French, removes the gum by fermentation brought about by soaking the silk in tepid water for a week. Dilute acid or alkaline solutions are also used as gum solvents.

After the silk is freed from gum, the filaments are separated by beating or tearing open, and formed into a sliver by carding or combing. They then pass through the drawing and roving machines and reach the spinning frame or mule, where they are twisted into thread — singles, two-ply or three-ply yarn, according to the doubling and twisting that is given.

At this stage, spun silk has a rough, dull surface because of protruding ends. Luster is given by singeing these in a gas flame.

Uses. — Spun yarns are used for filling in silk fabrics, for warp velvets, knitting yarns, dress trimmings, linings, elastic webbings, hosiery, sewing silk, lace, plushes and insulating materials.

The United States uses large quantities of spun silk. Importations of silk waste have amounted to about 6,000,000 pounds yearly.

Finished products. — *Yard goods.* — Silk is preëminently a textile for dress materials, by reason of its beauty of sheen and color, light weight and natural endurance. A list of silk fabrics can be found at the end of the chapter. It comprises plain, figured and corded silks, brocades, satins, velvets and plushes. No other material can command such a high price: the coloring, design and workmanship of some brocades, for example, make a garment of them worth many hundreds of dollars. Silk upholstery materials also come in a wide range of fabrics, some of them commanding

a high price. Tapestries have been and are being made which are of lasting value as works of art.

Knit goods. — This class of silk goods includes gloves, hosiery, underwear and sweaters. As is well known, these articles are more expensive, but in most cases far more desirable, than their cotton or wool equivalents. Underwear of silk to be worn next the skin is ideal in that it is cleanly, and has good heat-regulating properties. The jersey weave is also largely used for silk petticoats.

Underclothing. — Crêpe de chine and other soft silks are much in vogue for chemises and night dresses. When of good quality they give good satisfaction. Taffetas are almost universally used for silk petticoats. Stiff taffetas wear poorly for this purpose, and do not justify the expense. Soft taffetas generally wear better.

Ribbons. — As early as the eleventh century ribbon weaving was established at St. Étienne, France, and this town still leads in the industry. A ribbon loom is so arranged that from two to forty webs can be woven simultaneously on it.

Ribbons are found in the following varieties:

1. Taffeta, both plain and moiré. The moiré effect on ribbons may be permanent, produced by the moiréing machine, or a more superficial finish.
2. Grosgrain. A cross ribbed grosgrain with a cotton cord woven in for strength is used for watch ribbons. Satin grosgrain comes in different widths, for tie laces, hat trimming, etc.
3. Satin.
4. Messaline.
5. Velvet, in colors or black, and with satin or silk back.
6. Novelty ribbons, including Dresden and brocaded effects. The maximum width is about twelve inches, and the maximum price about $10 to $12 per yard.
7. Picot edge ribbons, in plain ribbed or novelty weaves.
8. Wash ribbons, usually in narrow widths for use in underwear.

The numbering of ribbons according to width is not standardized

above No. 12. Below that certain widths are known by numbers, as, one-half inch wide is No. 2; one inch wide, No. 5; one and one-half inch, No. 12.

Silk threads. — This country excels in the manufacture of this line of silk goods, and immense quantities are produced for home consumption and export. The principal varieties are sewing silk and machine twist, but embroidery and crochet silk, Persian and Roman floss, dental floss and surgeon's silk are some of the many kinds that are made to meet special uses.

Sewing silk is made by twisting two groups of threads, then combining these two groups with a twist in the opposite direction. Machine twist uses three groups in the same way. Embroidery silk is made by slightly twisting a number of untwisted threads, then doubling and twisting loosely in the opposite direction.

Miscellaneous. — Large quantities of silk are used for neck-wear, dress trimmings, embroideries and laces, umbrellas and parasols; and for insulating materials, filaments for incandescent lights and other scientific and commercial needs.

Artificial Silk

For almost two hundred years the possibility of producing a substance similar in most respects to cocoon silk has engaged the attention of chemists. The problem required the discovery of a substance which could be pressed out through capillary tubes in the form of a filament having the properties of the natural product. Working in different ways, but with the same main idea in mind, several chemists in the latter part of the nineteenth century succeeded in making a form of artificial silk. Of these, Chardonnet, in Besançon, France, was the first to make his invention practical, and his silk is one of the leading varie-

ties of commerce to-day. It is of the type known as nitrocellulose silks.

Varieties of artificial silk. — *Nitrocellulose silk.* — This is produced by treating cellulose in some form, usually purified cotton waste, with a combination of nitric and sulphuric acids of a certain strength and temperature. The product is a nitrated cellulose. Gun cotton is a similar product. After pressing out the excess acid and washing, the compound is dissolved in a mixture of alcohol and ether, and becomes collodion, a well-known substance which hardens on exposure to the air. From the reservoir in which it is stored it is forced through capillary tubes, so small that the outcoming filament has approximately the diameter of true silk. As the thread reaches the air it solidifies, and is carried to a bobbin and wound in skeins. It is still far from being a textile fiber, as it is highly inflammable and lacking in strength. It is now given chemical treatment which denitrates it and turns it back practically into cellulose, in a new form which has strength, flexibility, fineness and more luster than natural silk.

Cuprammonium silk. — A similar product is made by dissolving cellulose in ammoniacal copper oxide, making cuprate or cuprammonium silks, known in Germany and elsewhere as Glanzstoff.

Gelatin silk has been made by forcing a water solution of gelatin through capillary tubes, drying the filament, and treating it with formaldehyde, to make it insoluble in water. It has little commercial value.

Viscose silk. — Chardonnet and cuprammonium silks are manufactured in England and on the continent of Europe, but in the United States a variety known as viscose silk is exclusively produced. In its preparation wood pulp is ground with solid caustic soda, and mixed with carbon bisulphide. The resulting mass is a plastic, viscous sub-

stance known as viscose. It can be made into moldings, artificial leather and other substances, but its chief use is for making wood fiber silk. The viscose is dissolved in water, filtered and forced through platinum capillary tubes under great pressure. Passing directly into a bath of ammonium and sodium sulphates, it is hardened. After bleaching and further finishing, the silk is ready for the market. It is of good quality, and more brilliant than natural silk.

Properties of artificial silk. — Except for its high luster and affinity for dyes, artificial silk does not yet rival the natural product in its properties. It is harsher and less elastic, somewhat coarser, and has been about one-third as strong. A serious drawback has been that it is weakened by being wet, but its strength, both in the dry and wet condition, is being increased by improved methods of manufacture, and it now stands washing fairly well.

Uses. — Artificial silk is entering all branches of silk manufacture. It is woven into dress goods, either alone or in combination with silk or cotton. It is knit into sweaters which have great vogue because of beauty of color and luster. Attractive "plated" hosiery is made of viscose or wood fiber silk on a cotton foundation. These stockings are much cheaper than natural silk, are far more durable than the medium grades of the latter, and stand washing very well. Dress trimmings, men's ties, ribbons and embroidery silk are some of the other ways in which artificial silk is employed.

Production. — In 1912 the artificial silk output for the world was over 8000 tons, valued at about $39,000,000. Since then its production has increased rapidly.

Other silk substitutes. — In Madagascar a spider is found which spins a silky filament which can be utilized, and in Sicily a shellfish produces what is called Pinna silk, used locally for making articles of wearing apparel.

Several plants and trees, for example the milkweed and some of the tree cottons, produce silky filaments called vegetable silk. This silk has textile value for stuffing pillows and other upholstery and decorative uses, but as a rule is too weak for weaving into fabrics.

QUESTIONS

1. Give an account of the early history of silk culture and its introduction into Europe and America.
2. Describe the appearance and life of the caterpillar which produces cultivated silk.
3. Give differences between wild and cultivated silk as to origin, appearance and use.
4. Describe the work of the silk reeler. What is the character of the reeled thread?
5. Why does silk have to be "thrown"? What are the principal operations of throwing?
6. Distinguish between singles, tram and organzine, and give a use for each.
7. What changes in silk does degumming effect?
8. What is weighted silk? Why does it usually wear badly?
9. Give the manner of weaving the following: Brocade, velvet, crêpe de chine, bengaline, peau de soie.
10. What are the sources of waste silk, and why does this silk need special machine treatment?
11. Give illustrations of the wide range of uses to which manufactured silk may be put.
12. Give the method of making viscose silk.
13. Compare artificial and natural silk as to physical properties.
14. In what fields is artificial silk competing with the natural product?

Questions and Problems for Further Study

1. Consult encyclopedias and other sources of information, and write papers on:
   a. The early history of silk culture in America.
   b. Silk manufacture in the United States at the present time.
2. Collect samples and learn to know at least ten silk fabrics by name, weave, general appearance and appropriate uses.

SILK

Name	Price	Width	Weave
Armure	$2.75–$4.00	39″	
Baronette	$4.50	40″	Twill
Bengaline, Plain	$2.00	22″–36″	Plain cord
Bengaline, Radiant	$1.50–$3.50	27″–36″	Plain cord
Brocade Satin	$2.00–$5.00	27″–40″	Figure
Brocade Charmeuse	$3.50–$6.00	40″	
Chiffon	50¢–$1.00	40″	Plain
Chiffon Cloth	95¢–$1.25	40″–44″	Plain
Chiffon Taffeta	$1.50–$2.25	36″	Plain
Charmeuse	$2.00–$4.00	41″	Twill
China Silk	59¢–$2.50	27″–45″	Plain
Crêpe Charmeuse	$2.50–$4.50	40″	Plain
Crêpe de Chine	$1.50–$3.50	40″	Plain
Crêpe Georgette	$2.00	40″	Plain
Crêpe Meteor	$2.00–$4.00	40″	Plain, twill
Crêpe Faille Sublime	$2.00–$3.00	36″	Twill
Crêpe Kitten's Ear	$4.25	44″	Plain
Faille	$2.00–$3.00	36″–40″	Plain cord
Foulard	$1.00–$3.50	27″, 36″, 40″	Twill
Gauze	$4.00–$5.00	45″	Gauze

MATERIALS

Character	Use	Wearing Quality
Heavy silk, small ridgy pattern like bird's-eye	Dresses, trimming, millinery	Excellent
Smooth satin surface, high luster	Skirts, sport suits	Wears well, washable
Smooth fabric with rounded silk cord like poplin	Dresses, trimming, millinery	Good
Soft and heavy filling, surface reflects light in points	Dresses, trimming, millinery	Good
Pattern in relief. Woven on Jacquard loom	Dresses	Excellent
Soft, rich, droopy, piece-dyed fabric with dull luster, woven pattern	Dresses	Excellent
Thin, gauze-like fabric	Veils, trimmings, waists	Fair
Like chiffon, but heavier in weight and more durable	Waists, etc.	Good
Soft taffeta	Dresses, waists	Good
Thin, highly finished lustrous silk	Gowns, waists	Good
Soft, light-weight silk of China, Japan and India	Linings, waists	Excellent, washable
Soft, rich, piece-dyed fabric, dull luster	Dresses	Good
Serviceable, dull, soft silk, thread twisted in spinning	Dresses	Excellent, washable
Thin gauze silk crêpe	Waists, sleeves	Excellent, washable
Like crêpe de chine on wrong side, soft twill satin on the other	Dresses	Excellent
All silk heavy grosgrain with hard twisted filling	Dresses	Good
Like crêpe meteor, but softer and more lustrous	Gowns, waists	Good
Surface in light ridges	Dresses	Good
Soft, thin, figured silk. Plain twilled foulard is silk serge	Dresses	Excellent, washable
Very thin, light, open work fabric, sometimes cotton	Dresses, curtains	Fair

SILK

Name	Price	Width	Weave
Gloria	$2.00–$4.00	40″	Plain
Grenadine	$2.50–$4.00	40″	Gauze
Grosgrain	$2.00–$5.00	18″–40″	Plain cord
Habutai	$1.25–$1.50	36″	Plain
India Silk like China Silk			
Jersey Silk	$3.50–$5.50	36″ and 72″	Knit
Khaki Kool	$3.50–$4.50	36″–40″	Plain
Lisse (Crêpe Lisse)	$1.75–$4.00	40″	Plain
Louisine	$1.00–$3.75	36″–49″	Plain
Maline	25¢	27″	
Messaline	$1.25–$4.00	27″–36″	Twill
Moiré	$2.50–$5.00	40″	Plain Moiré
Peau de Cygne	$1.25–$2.25	36″	
Peau de Soie	$3.50–$4.25	40″	Plain
Pongee	$1.50–$3.00	27″–33″	Plain
Poplin	$1.50–$4.00	36″–40″	Plain cord
Plush	$3.50–$6.00	24″	Pile
Persian	$3.50–$5.00	36″–40″	Plain
Radium Silk	$2.00	33″	Plain
Rajah	$1.75–$2.50	36″	Plain

MATERIALS — *Cont.*

Character	Use	Wearing Quality
Cloth with silk warp and worsted filling	Umbrellas	Excellent, durable
Thin open-weave silk, sometimes figured	Dresses	Excellent
Light corded silk of semi-dull finish	Dresses, coats	Great durability
Japanese silk heavier than China silk. Heavy sizing on warp and filling, afterwards boiled out	Waists	Excellent, washable
Lustrous, soft finished, closely knit fabric	Sport suits	Wears well
Heavy ribbed silk for sport wear, printed pattern	Sport suits	Good
Thin smooth fabric, stiffened	Ruchings, trimmings	Fair
Silk with coarse meshy surface like basket weave	Dresses, waists	Excellent
Lace netting with hexagonal mesh	Millinery	Fair
Twilled back satin finish light weight material named after Messalina, wife of Roman Emperor Claudius	Dresses, ribbons	Good
Watered or clouded silk, effect produced by heavy pressure and heat	Skirts, suits, ribbons	Excellent
Soft highly finished silk much like peau de soie	Dresses	Excellent
Silk woven like grosgrain but with rib so fine that it produces plain woven face with satin effect	Dresses	Excellent
Thin soft silk woven from natural uncolored raw silk. Product of silk worm that feeds on oak leaves	Dresses, waists, suits	Excellent
Repped dress silk, sometimes wool filling. A corruption of French Popeline introduced during the early part of the sixteenth century at Avignon	Dresses, skirts, suits	Excellent
Long pile fabric of velvet class	Coats, curtains	Good
Soft thin silk formerly used for linings	Gowns, linings	Fair
Thin lustrous silk	Waists	Good
Rough silk of irregular threads. Like Pongee	Dresses, suits, coats	Not very durable

SILK

Name	Price	Width	Weave
Satin	$2.00–$3.00	36″	Satin
Satin de Chine	$2.00–$5.00	40″	Plain
Skinner's Satin	$1.75–$2.25	36″	Satin
Shantung	$1.50	33″	Plain
Taffeta	$1.50–$2.25	27″–40″	Plain
Taffeta, Pussy Willow	$2.50–$4.50	40″	Plain
Tricolette	$6.50	36″	Knit
Tub Silk	$1.35	36″	Plain
Tulle	$2.00–$2.50	3 yds.	
Velvet	$2.00–$20.00	18″–42″	Pile

MATERIALS — *Cont.*

Character	Use	Wearing Quality
High gloss, soft, heavy and light	Dresses, suits, coats	Good
Soft drapy satin with crêpe-like finish	Waists, dresses	Good
Heavy satin, cotton back	Linings	Excellent
Heavy grade of natural pongee	Suits, drapery	Excellent
One of oldest silks known derived from Persian Taffeta. Thin silk, glossy	Dresses, waists, suits	Fair
Like Taffeta but softer and more lustrous	Dresses, waists	Good
Heavier than Jersey cloth	Dresses and sport suits	Wears well
Thin silk that will wash. Usually striped	Waists	Excellent
Kind of thin openwork silk net	Neckwear, veiling	Fair
Closely woven pile fabric	Coats, trimmings, suits	Good

CHAPTER VIII

TEXTILE TESTING

Why textile testing is necessary. — A practical use of the study of textiles in the preceding chapters is the aid it gives in purchasing. To be a good purchaser of textiles, one should know something more about materials than their outward appearance. So far in this book we have considered the name and appearance of typical fabrics, the price, width and reputed content, the weave, wearing quality and use. Only the perfect fiber, the typical weave and the pure fabric have been dwelt upon. Actual analyses of fabrics reveal sharp differences between them; the different classes of material subdivide into grades of value. Some fabrics are adulterated with inferior fibers, not always indicated by appearance or price; inferior weaves are found con-

cealed by surface dressings; the fiber itself, though pure, may be of such poor quality that the weave it makes will not stand the strain of wear. So it is quite as necessary to use tests for the purity and value of textile material, in order to purchase wisely, as it is to know the name and general characteristics. Even an expert cannot always judge material by the look and feel, and unless the consumer assures herself by test that the material she is about to buy is a good return for her expenditure, she has no guaranty of it except the uncertain ones of the reliability of the store and the price. Salespeople seldom know the content of all their goods, and sometimes unintentionally misrepresent them. In one store of good standing a salesman assured a customer that a grade of toweling was linen and cotton, when it was all cotton, and that another grade contained cotton, which proved to be all linen. Many purchasers would be misled by the statement of a salesgirl in a reliable store, that all baby flannel contained cotton.

There is evident need of legislation providing for the proper labeling of textile materials, but repeated efforts in Congress have failed thus far in framing a law which will fit all cases and be just to both manufacturer and consumer.

In these present times, when prices of wool, silk and linen are soaring, the cheaper cotton is used more than ever in combination or as a substitute. One mill alone, in the past year, has increased the number of looms using a cotton warp with a wool filling from 31 per cent to 77 per cent. No objection can be made to this use of cotton provided the fact is known, and the fabric sells for what it is, at a suitable price. However, so much skill is shown by manufacturers in concealing cotton in a mixed weave, or in giving it the appearance of wool, that it is a matter of ordinary good sense for the purchaser to safeguard herself by a few simple tests.

Nature of tests. — For ordinary purposes, the tests necessary to analyze a fabric and get a sufficiently accurate knowledge of its value are simple and do not require elaborate apparatus. The tumblers and agate pans of the kitchen may be substituted for the flasks and crucibles of the school laboratory. It is of more value to most students of textiles that they get a working knowledge of a wide range of materials, than it is to perform difficult quantitative tests on a few.

Recording the tests. — To be of value for reference, samples of the fabrics studied, with the results of the analyses, should be kept in permanent form. The card catalogue method is probably most convenient. Several samples of such fabrics as have a wide range in price should be studied and catalogued, in order to be representative, and show the relation of price to satisfactory quality. For example, the material known as shepherd check has been selling from 49 cents to $4 per yard. On analysis, it is found that at a certain price the material will be about three-fourths cotton; going up the scale, half cotton; a little better grade will be all wool, but light and sleazy, and so on. Then comes a grade which answers all the tests satisfactorily and is reasonable in price. The catalogue records this as a standard, and adds one or two higher grades for comparison. Materials for study may be bought in small quantities and divided among a group, making the cost small for each student. When the catalogue is complete as to the representative materials on the market, it will be found a time and money saver. A reference to it before a shopping trip often saves time in making decisions in the stores; as a money saver, it presents a range of material wide enough to suggest a choice between high-priced or equally serviceable moderate-priced fabrics for the suit or dress.

Analysis of fabrics. — The main points in the study of a

fabric are the fiber content, the kind and quality of the weave, the dressing, weighting or other finishing, and the questions of fading, spotting and shrinking. The following outline of headings is suggested for a typical card record:

DRESS MATERIAL

Name — Character of material
Price — Width — Cost per square yard
Place and time of purchase
Weave: Kind — Picks — Ends — Quality
Weight per square yard
Fiber: Warp — Filling — Quality
Dressing or weighting
Fastness of dye
Shrinkage
Uses
Remarks (standard quality, below standard, etc.)

Beginning the study. — Following the name of the material, the general character is noted, as for example woolen or worsted goods, heavy or light weight, lustrous or dull appearance, harsh or soft feel.

The feel of material is a guide to its content. Cotton feels soft and inelastic; all wool material is springy and elastic; silk also is elastic but smoother than wool; linen is inelastic and has a firmer, stiffer feel than cotton.

The price per square yard is figured, as a basis of comparison with other priced materials of the same kind. This is an important point; the inexperienced purchaser is apt to compare fabrics as to price alone, while often the higher priced of two samples will figure lower per square yard and cut to better advantage, because of its width. As an instance, a silk 24 inches wide at $1.10 per yard costs 15 cents more per square yard than the same material 42 inches wide at $1.75.

Weave. — A linen tester or pick glass is necessary for a study of weaves. By it are determined:

1. The *kind of weave*, whether plain, twill, satin, etc.

2. The *number of picks and ends*, which indicates the relative density and durability. This is done by counting the threads running each way in the half inch or inch square magnified by the glass. In comparing materials, if the yarns are of the same size and quality, the fabric which has the highest counts is the most durable. It is especially important to use this test for standardizing sheeting, underwear muslin, and table damask.

3. The *character of the yarn.* — First, whether single, two-ply or three-ply. Strength of yarn is proportional, as a rule, to the amount of twist. Second, whether carded or combed. Third, as to the length of the fiber. Quality is directly connected with this. Long fibers give strength, short fibers and flocks give a weak weave.

The *quality of the weave* is further determined by the following tests:

(*a*) Separate the warp and filling threads and test the strength of each separately.

(*b*) Place the thumbs close together on the material, and holding it firmly, press downward. Test in both directions of the cloth. If it gives badly, it will not stand strain in the garment. An expensive broadcloth may be sheared so close that it is easily split; a thicker broadcloth will be stronger if the fibers are of good quality; on the other hand, some cheaper thick broadcloths are weak because made of short-fibered shoddy.

(*c*) Try whether the threads of warp and filling move easily, or run a needle in a fold of the cloth as if making a tuck, and pull away from each side. If the needle punctures widen into holes the fabric will pull at the seams.

(*d*) Notice any peculiar construction of weave. A dimity or crossbarred muslin breaks along the line of the heavy cord; a corded material such as bengaline frequently has

its light weight warp threads cut or frayed by the heavy filling cords; long floats, as in some pattern fabrics, soon break.

(*e*) Test the strength of muslins and similar cotton goods by tearing slightly at the edges.

(*f*) Hold the material to the light and note evenness of thread, closeness or looseness of weave, and evidence of filling substances such as starch.

Weight per square yard. — This may be found by weighing a small square of the cloth which has been accurately measured and cut, and estimating from it the weight of the square yard. Interesting comparisons can be made between different grades of the same material, *e.g.*, in broadcloths, gabardines and serges. Conclusions from this test as to comparative values are modified by many factors, such as dressing and weighting, introduction of cotton in wool or silk material, and fineness or coarseness of yarns.

The analysis of the fibers is the most detailed branch of textile testing. It includes microscopic, physical and chemical tests.

Microscopic tests. — The typical appearance of the textile fibers, as given in Chapter I, should now be reviewed in connection with the study of the kind and quality of the fibers in the fabrics analyzed. The microscope shows better than any other means the identity of a fiber and its quality. It is often the only sure method of identifying linen. In the laboratory it should be used in preference to chemical tests for linen analysis, and it is also helpful in distinguishing between cotton and mercerized cotton, and between cultivated and wild silk.

The temporary mounts for the microscope are made by placing two or three individual fibers in a drop of water on the glass slide, and covering with a cover glass. Permanent mounts are made with Canada balsam.

Physical differentiation tests. — It is not necessary to apply every one of the following tests to a given material, but the evidence of several should be taken.

1. Tearing. — Tear the material. Cotton tears more easily than linen, with a shrill sound, whereas linen gives a dull sound. The same differences are found between silk and wool, silk tearing more easily, with a shrill sound.

2. Breaking. — Hold a piece of the yarn between the thumbs and first fingers, and with a steady pull break apart. Observe the parted ends. Cotton fibers curl in all directions; linen fibers appear straight, pointed and parallel, with uneven ends. Wool fibers are kinky and stiff; silk is straight, fine and lustrous.

Chemical differentiation tests. — 1. Burning. — (*a*) Burn the ends of several threads of the warp and filling in the flame of a match. Notice differences in the manner of burning and the residue. Cotton, mercerized cotton and linen burn quickly, like paper, and leave very little white or gray ash. Artificial silk flashes up even more quickly. Wool and silk burn slowly, and char to a black gummy ball. Both give the characteristic odor of animal matter when burning; in wool it is that of burning hair. If the silk is weighted with mineral salts, it will not ball up nor be consumed, but will keep the shape of the fabric after the flame has died out.

Repeat the tests, first untwisting the ends of the yarns to expose all the fiber content. Does the burning show any combination of animal and vegetable fibers in a single yarn? Cotton may be carded or combed into wool before the yarn is spun; it may be entirely concealed in the core of a yarn which has wool for the outer covering or veneer; it may be introduced for the sake of dyeing effects as an occasional thread in novelty materials, covert cloth, etc.; in corded material it frequently makes the filling cord;

in mixed goods it is often used for the warp, with a wool filling.

(*b*) Burn a sample of wool material in a dry test tube. Hold a piece of moistened red litmus paper in the mouth of the tube. Ammonia given off in burning will turn the litmus blue. Moisten a roll of filter paper in a solution of lead acetate and hold in the fumes. Wool contains sulphur, which is deposited on the paper as silvery black lead sulphide.

Take another test tube and repeat with silk. Silk gives the ammonia test but does not contain sulphur by nature. If lead sulphide is formed it is due to sulphates used in the weighting, and the deposit is not so marked as in the case of wool.

Repeat with cotton or linen. The odor is like burning wood. Hold a piece of moistened blue litmus paper in the mouth of the tube. It turns red, due to a volatile acid, impure acetic, which is given off when vegetable fibers are burned away from direct contact with air.

2. Action of Alkalies. — (*a*) Place a sample of wool, silk and cotton or linen in a porcelain or agate dish and cover with a solution of caustic soda of about 5 per cent strength. Gradually heat to boiling and observe which kind of material is destroyed. Could this alkali be used to separate animal and vegetable fibers in a mixture? Boil another set of samples in a strong solution of laundry soap for fifteen minutes. Is the wool or silk made tender?

(*b*) Repeat the test, using samples of white material, and covering with a 5 per cent solution of washing soda. Boil for five minutes. Remove, wash and observe any changes in the material. Should washing soda be used in laundering wool or silk?

(*c*) Repeat with white materials, and a 5 per cent solution of borax. Does it have the same effect as washing soda on wool or silk?

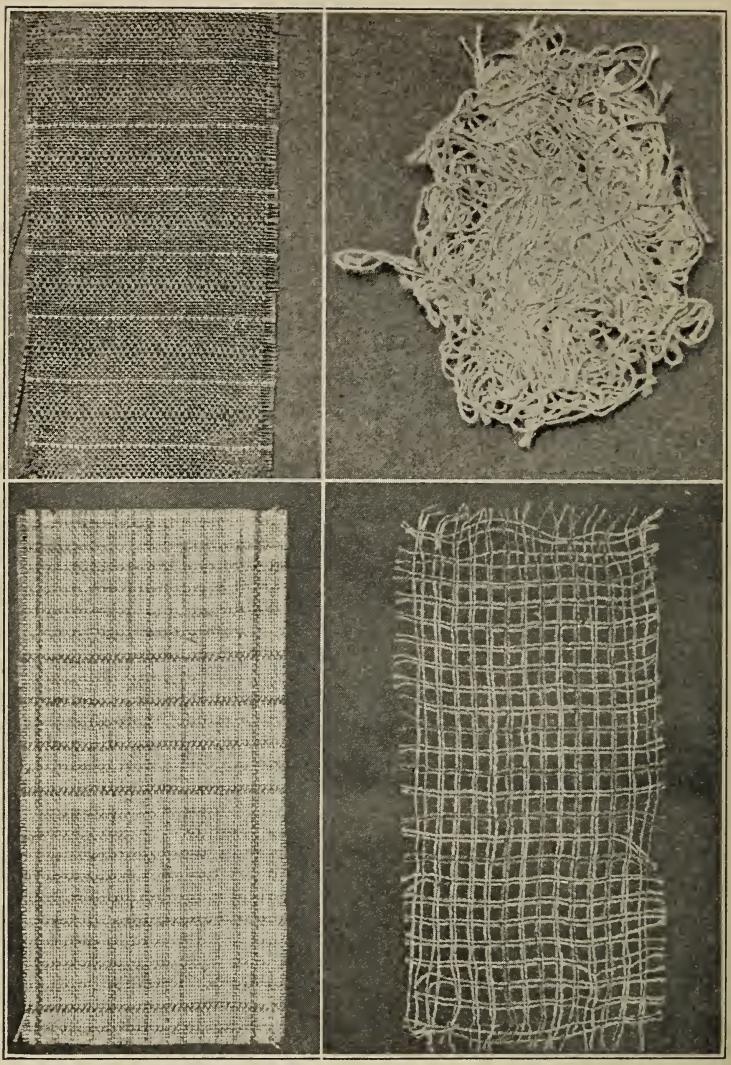


Fig. 69. — Mixed Wool and Cotton Fabrics Treated with Caustic Potash.

The original material and the cotton residue are shown.

3. Action of Acids. — (*a*) Arrange a combination of samples as before, and cover with 40 per cent hydrochloric (formerly called "muriatic") acid. Do not heat. Note which kind of material is affected, and the time required for complete destruction. How might this acid be used in fabric analysis?

(*b*) Repeat, using strong sulphuric acid, and samples of both cotton and linen materials of about equal weight. Do not heat. (This test and the following are not suitable for home trial.) Which materials are destroyed, and in what time? Did linen or cotton succumb more quickly? The strength of the fabrics in the solutions may be tried from time to time by manipulating them with glass stirring rods.

(*c*) Repeat with white materials, using nitric acid of about 50 per cent strength. Which class of materials becomes colored? Which disintegrates?

(*d*) Repeat with 20 per cent acetic acid. Is there any destructive effect?

4. Color Tests. — (*a*) Nitric acid, as shown above, colors wool and silk yellow, while cotton and linen remain uncolored. Like other color tests, it is useful only on white or light colored material. In all such tests the material should be fringed to a depth of a half inch or more, both warp and filling ways. The color change then shows to advantage, particularly if the warp is cotton and the filling wool or silk. These tests are misleading if cotton is used as a core in wool or silk yarns, as it will not appear unless the end of the yarn is untwisted before the test is made.

(*b*) Moisten a fringed sample with Millon's reagent [1] and heat gently. Animal fibers are colored red; vegetable fibers are not colored.

[1] Prepare Millon's reagent by dissolving 100 grams of mercury in 71.5 cc. of nitric acid of 1.4 specific gravity in the cold. When action ceases, add twice the volume of cold water.

(*c*) Stain a fringed sample with picric acid. Animal fibers are colored yellow; vegetable fibers are not colored.

5. Alkali Separation of Animal and Vegetable Fibers. — This test is applied to any wool or silk material, to determine whether it contains cotton. Linen is not considered as a possible adulterant, being too expensive. Boil a sample of the material for ten to fifteen minutes in a 5 per cent solution of caustic soda or caustic potash (sodium or potassium hydroxide). If the testing is done at home, a solution of Babbitt's lye in the proportion of a tablespoonful to a pint of water will answer for the alkali. In boiling, keep the solution at constant strength by bringing up to bulk with water, or use a flask with a reflux condenser. A long piece of glass tubing rising vertically through the cork of the flask serves the purpose.

After the given time of boiling, the wool or silk will be destroyed. The residue of vegetable fiber is now removed from the flask, washed and examined. If it remains a close weave, it was blended into the fabric in both directions, probably as the core of the yarn. If it is an open weave, of a crossbarred effect, as in the illustration, the yarns of warp and filling were animal and vegetable in alternation. Loose threads signify that either the warp or the filling was entirely of wool or silk. This test is the most valuable of the differentiation tests, as it applies to many cases, it shows the method of combination and the proportion of each kind of fiber in the weave. An approximate quantitative estimation may be made as follows:

Weigh the sample in air-dry condition, boil, remove the residue carefully, wash free from alkali, and restore to air-dry condition. Weigh. Estimate that the cotton in the sample has lost 5 per cent of its weight by the action of the boiling alkali. Therefore divide the weight of the residue by 0.95 and divide the result by the original

weight of the sample. The quotient will be the percentage of cotton.

For example:

Weight of sample = 2 gms.
Weight of residue = .8 gm.
Corrected weight of cotton = .84 gm.
Cotton in sample = (.84 ÷ .2) × 100 = 42 per cent.
Wool in sample = 58 per cent.

To distinguish between wool and silk in the above test, add lead acetate to the alkali solution of the fiber. If wool is in solution, the color will become black because of the sulphur in wool; if silk, there will be no change. As the color of the solution may be already dark from the dye in the sample, a clearer test for wool-silk mixtures is the following:

6. For Wool-Silk. — Cold 40 per cent hydrochloric acid will destroy silk in about two minutes, unless it is heavily weighted with minerals. Wool will be scarcely affected. In a wool-silk mixture, the test may be made quantitative by taking the weight of the sample and the wool residue, and allowing 0.5 per cent for loss of wool.

7. For Silk-Cotton. — (*a*) The caustic soda separation given above may be made quantitative for silk-cotton mixtures.

(*b*) Cold 40 per cent hydrochloric acid (1.2 sp. gr.) destroys silk. Cotton is affected to the extent of about 4 per cent of its weight.

(*c*) Silk is destroyed by copper glycerol solution,[1] cotton is hardly affected.

8. For Cultivated and Wild Silk. — An identification

[1] The copper glycerol solution is prepared by dissolving 16 gms. of copper sulphate in 150 cc. of water, with the addition of 10 gms. of glycerol. Gradually add a solution of caustic soda until the precipitate of copper hydroxide which is at first formed just disappears.

test for wild silk as against cultivated is particularly applied to pongee and some upholstery materials. Typical pongee is made of wild silk. It may be manufactured of cultivated silk made to look like wild, or of a combination of both. The substitution of cultivated silk in whole or in part does not wear so well as good quality pongee from wild silk. Wild silk does not dissolve in 40 per cent hydrochloric acid so rapidly as cultivated silk ; from a half hour to an hour is required.

Hot caustic soda also dissolves cultivated silk in ten to fifteen minutes ; wild silk in about an hour.

Wild silk may be combined with cotton in cheap pongees. The burning test, or a color test for animal and vegetable fibers, will distinguish the two.

9. For Artificial Silk and Other Fibers. — Artificial silk is found alone in many fabrics, or if in combination, it is generally with silk or cotton.

(*a*) The burning test plainly distinguishes artificial silk from true silk. It is less plain for artificial silk and cotton, although the latter burns rather more slowly.

(*b*) About the best method of separating artificial silk from any other fiber is to immerse the fabric in cold 10 per cent caustic soda. Artificial silk begins to gelatinize at once ; no other fiber is affected so soon. The cotton foundation of a " plated " fiber silk stocking can be revealed by this test. Since artificial silk is so susceptible to caustic alkalies, strong soap should not be used in washing it.

(*c*) The solution of copper glycerol mentioned above destroys true silk, but does not affect artificial silk.

(*d*) True silk is colored by Millon's reagent and by nitric and picric acids ; artificial silk is not.

10. For Cotton and Mercerized Cotton. — Cotton may receive a surface finish by calendering, which resembles

mercerization. The effect is not permanent, but soon disappears in laundering.

To determine whether a sample of new material is mercerized or not, first remove all starchy dressing according to the method on page 199. When iodine gives no test for starch in the fabric, moisten it with water and place it for a few seconds in a solution made by dissolving 20 gms. of iodine in 800 cc. of a saturated solution of potassium iodide. Remove the sample, wash thoroughly, and let it lie in water. Mercerized cotton remains blue or black until the iodine volatilizes; unmercerized cotton fades quickly to brownish yellow.

The microscope should be used, if possible, to determine not only the presence but the quality of mercerization.

11. For Mercerized Cotton and Silk. — The appearance of the two fibers is similar because of their luster. They can be separated and identified by the methods used for ordinary cotton and silk.

12. For Cotton-Linen. — These two fibers, when fully bleached, are practically identical chemically, so that there are at present no satisfactory chemical tests to distinguish them in fine weaves. It is therefore very difficult to make sure of the purity of a linen fabric, particularly as cotton may be made to look like linen by beetling and dressing. The microscope is the only certain means of identification. Many students of textiles depend upon the tearing and breaking tests, already given, and they are helpful, especially with experience back of them.

A spotting test is sometimes made, and is excellent on dressing-free material. It depends on the fact that linen absorbs moisture more readily than cotton does. A drop of ink on linen sinks in rapidly and makes a round spot; on cotton it stands on the surface and when it is absorbed spreads unevenly.

Singed ends of linen fibers are even and compact; cotton fibers spread out like a paint brush.

The following tests work well on fringed samples of huck toweling or similar coarse weaves. Try them on union huck toweling until the results are familiar before testing unknown material.

(*a*) Fringe a sample to expose warp and filling threads, and heat for two minutes in a strong solution of caustic alkali, such as 50 per cent caustic potash. Remove and dry between filter paper. Linen becomes brownish yellow, cotton white or light yellow.

(*b*) There is enough difference between the absorptive capacity of linen and cotton to give good color tests in materials of rather coarse texture.

Warm a fringed sample in a weak alcoholic solution of cyanin until the dye has penetrated the material. Remove, wash slightly, and lay in water to which only a drop or two of sulphuric acid has been added. Linen fibers are colored blue; cotton takes up very little color. If the blue color is faint, it can be intensified by placing the sample in weak ammonia water.

(*c*) Warm a fringed sample for a few minutes in an alcoholic solution of rosolic acid, wash and dip for a second in strong caustic soda. Wash. Linen becomes rose red, cotton is almost colorless.

Removal of dressing. — In buying household muslins or linens, particularly table damask, the amount of dressing in the material is important. A piece of damask may look and feel smooth, firm and heavy, but after a few washings it will be seen that the appearance and weight were given by starchy or other dressings, and the weave is now thin and sleazy. Reliable dealers, and the price, are guaranties of value to a considerable extent, but the purchaser should make any practicable test for dressing before buy-

ing, especially if purchasing linens by the yard in large quantities.

Good table damask feels leathery rather than stiff.

Rubbing a piece of the material between the fingers will often loosen starchy dressing so that it appears as a powder on the surface.

Hold the material against the light. The dressing sometimes shows in the interstices of the weave.

Dressing may be removed in several ways:

(*a*) Rub the material well in cold water, to remove as much starch and other sizing as will come out. Then boil in successive waters until iodine does not show the presence of starch. To make the iodine test, touch the material with a drop of very weak iodine. A blue color appears if starch is present. The removal of starch is a slow process, as it is not soluble in cold water, and soluble only to paste form in hot.

(*b*) Using a reflux condenser, boil the sample not longer than 15 minutes in a 5 per cent solution of oxalic acid. This changes starch to a sugar soluble in water, and so shortens the process considerably. Remove, wash thoroughly and test with iodine. If starch is still present, continue boiling in clear water.

Both these methods may be made quantitative by weighing before and after the treatment.

(*c*) Dannerth (*Methods of Textile Chemistry*) gives the following method of determining the amount of organic finishing material in a cotton fabric:

1. The percentage of filling materials. A weighed sample of the fabric is boiled consecutively in distilled water, 1 per cent caustic soda solution, and 1 per cent hydrochloric acid; each operation should be continued one hour. If the sample be finally washed and dried to constant weight at 105° C., the result will give the amount of absolutely dry fiber present. Add 8 per cent to obtain the normal air-dry weight.

2. The percentage of moisture in the air-dry fabric is determined by drying to constant weight at 105° C.

3. The percentage of fats and waxes is determined by extraction with ether in the Soxhlet apparatus.

4. The percentage of starch, etc., is determined by difference as shown in the illustration below:

Total filling materials . . . . . 22 per cent
Moisture . . . . . 12 per cent
Fats, etc. . . . . 5 per cent . . . 17 per cent
Starch, etc. . . . . 5 per cent

The quantitative test for mineral matter in the fabric is the ash which remains after ignition of the fabric in a crucible. The filling material may be soluble in water, *e.g.*, the chlorides of zinc, calcium, magnesium and sodium. The insoluble portion may consist of China clay, barites, gypsum, chalk, talc, lime or aluminium soaps. These latter compounds will, of course, be decomposed on heating.

Weighting of silk. — (See Chapter VIII.) It is a simple matter to test whether silk will wear well or not, so far as weighting is concerned. The mineral salts which destroy a silk by their weight and the cutting edges of their crystals will not burn in a flame.

Hold a piece of silk in a gas or other flame until combustion is over. If the residue holds the shape of the weave, it represents the mineral matter that covered the fiber like a sheath. Pure silk curls up to a black gummy ball on burning. Before purchasing taffeta especially, it is a safeguard to test a sample in this way. A piece of silk bought untested may prove a poor investment and split in the folds in a few wearings.

An approximate estimation of weighting can be made as follows:

Burn a weighed sample of the silk in a weighed porcelain crucible for at least one hour in a strong Bunsen flame. When nothing but ash remains, either as powder or in the shape of the fabric, cool the dish and contents and weigh.

The residue represents a low estimate of the weighting of the silk. It is expressed in percentage on the basis of the actual silk in the sample. For example, a sample weighs 1.5 grams. After burning, the residue is 0.9 gram. Therefore the silk in the sample is 0.6 gram, and the percentage of weighting is $(0.9 \div 0.6) \times 100 = 150$ per cent.

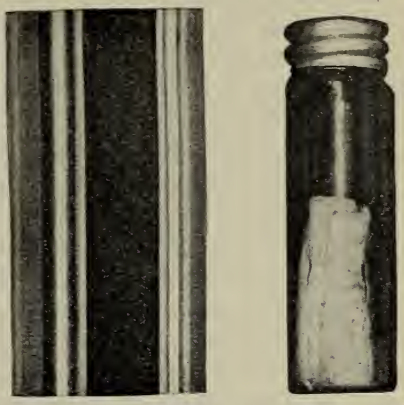


FIG. 70. — WEIGHTING OF SILK.
The bottle contains the mineral weighting left after burning a piece of silk like the sample shown.

Fastness of dye. — Some dyes are fast to light, some to washing, others to both influences. Upholstery materials, and some suit and dress materials, should be given a sunlight test; light summer fabrics should be tested for fastness to both light and washing if fast colors are particularly sought. One who continues to test materials and colors in this way will soon learn what particular colors to avoid — certain brown and plum shades in worsted suitings, for example.

The usual tests for the full trial of a dye are its fastness to light, washing, rubbing or crocking, perspiration, spotting and weathering.

Fastness to light. — Tightly cover one-half of the sample so that light is excluded, and expose the other half to direct sunlight. If the color has faded at the end of one or two weeks, the dye is fugitive; at the end of three, moderately fast; if it remains of good color after one month it is fast. This test may also be arranged to show the effect of weather and air.

Fastness to washing. — (*a*) Wash the sample of dyed or printed goods in pure water. If it "bleeds," it will not stand laundering.

(*b*) Wash the material with ordinary care, using tepid water and a small amount of good soap solution. Dry in the shade. Compare with the original material.

Light colors are sometimes fixed by soaking in salted water before washing, and adding salt to the rinsing water. The dyes usually used for cottons are made insoluble by salt. Other fixing agents are vinegar, turpentine and aluminium acetate. A little experimentation will show which is most satisfactory for certain colors. (See Chapter IX.)

Fastness to rubbing or crocking. — This is a test for coat collars, or hosiery and other dyed material that come next the skin. Rub the goods on a piece of white material and observe whether it darkens the latter. Crocking is caused by some defective process in the dyeing, which causes excess dye to remain on the surface of the fiber. It will occur if wool, for instance, has not been scoured free from grease, or because of hard water used in the dye bath, which precipitates the dye in insoluble form and deposits it on the surface of the material.

Fastness to perspiration. — (*a*) Steep the sample for five-minute periods in a solution of 50 grams of 50 per cent acetic acid and 100 grams of common salt per liter (Heerman). Dry after each immersion and examine for change.

(*b*) Dip a number of times in a solution of one teaspoonful of acetic acid to a quart of water kept at body heat (Dooley). Dry after each immersion and compare as before.

Fastness to spotting. — Sprinkle a sample of the fabric with drops of water and dry. Notice any change of appearance. This test is often applied to pongees and to other silk materials used for coats and raincoats.

Shrinkage. — If shrinkage is a factor to be considered,

as it often is in making up flannels and other washable wool fabrics, as well as cottons, it can be computed by cutting a sample of a given width and length, and washing with hot water and soap. If the raw edges are first overcast, there will be no loss of threads in the washing. Dry and iron without stretching. Measure the length and breadth again, and calculate the shrinkage in the sample and in the piece.

Dress materials of wool or worsted may show practically no shrinkage, or may shrink ten or fifteen per cent of their surface area. A loss of 100 square inches out of a square yard is something to be considered in making up a flannel or other wool material. Those fabrics seem to shrink most which contain curly, rather than hairlike, wool fibers, that have a carded rather than a combed yarn and in which the yarns lie close together in the weave.

Make comparative shrinkage tests on woolen and worsted materials. Which shrink more? Why?

From the data collected through applying the necessary tests to the materials under examination, the card catalogue is completed, and the samples classified as to their quality: Below standard, above standard or average.

A study of the tests enumerated in this chapter will show the student who wishes to analyze fabrics at home that two reagents are necessary: a caustic alkali, such as Babbitt's lye, and hydrochloric (muriatic) acid. With these two, practically all mixtures of fibers may be identified.

QUESTIONS

1. Give some reasons why a knowledge of textile tests is of value to the consumer.

2. Describe the tests you would use in deciding which of two serges would give the longer wear.

3. Which will do more harm to a wool skirt and a cotton waist respectively, a spot made by strong caustic soda or by sulphuric acid? What would be the proper treatment in each case?

4. What effect would the continued use of strong soap have upon woolen underwear?

5. Make a list of fiber combinations which caustic soda will separate.

6. For what differentiation tests may hydrochloric acid be used in the household?

7. Without a microscope, what tests might you use to distinguish linen from cotton?

8. What would be the appropriate quality tests for:

A piece of cretonne.
Pongee for a dust coat.
Table damask.
Taffeta silk.
Lavender cotton dress material.
Flannel for a waist.

9. Which is the better investment, a gabardine 48 in. wide at $2 per yard, or the same quality 54 in. wide at $2.19?

10. A piece of silk weighing 2.7 grams carries a weighting of 125 per cent. What is the weight of actual silk in the sample?

Questions and Problems for Further Study

1. Make quality tests on a range of samples of serge, plaids, checks, waist flannels, or any other well-known material, and draw conclusions as to the relation of price to value.

2. Find out by tests what wool-cotton mixtures will best take the place of all-wool material for school dresses.

3. Test the relative strengths and quality of weave of several kinds of white material which may be used for underwear.

CHAPTER IX

CARE AND REPAIR OF CLOTHING

Value of care of clothing. — It matters less how old and out of style a person's clothes may be than how well kept they are. Suits well brushed and pressed, clean and dainty neckwear and neat shoes, impress the eye of most observers more than the cut of the skirt or jacket. It requires the sacrifice of some little time each day to maintain a desired neatness in clothes for daily wear, but the return is twofold. There is a tonic effect on mental attitude and character in the consciousness of being well groomed, and further, clothes cared for mean money saved. One woman, by car-

ing for a suit, can wear it three seasons and still look well dressed. The same suit on another person, with the same kind of wear, looks shabby by the end of the first season, and has to be replaced.

Care of clothing a duty. — It is a patriotic duty, rather than a matter of personal choice, to take proper care of clothing at the present time. Raw materials which were plentiful in previous years are now so diverted from their accustomed channels to meet a special demand, that not only is their cost high, but the supply for general consumption is inadequate. This is especially the case with wool and leather. No article, new or old, of these materials especially, should be treated carelessly, or discarded as long as it is of any value. "Every housewife who practices strict economy puts herself in the ranks of those who serve the nation," is true now with regard to textile materials, and will be true probably for years to come, or until there has been a return of normal economic conditions all over the world.

General care of clothing. — To keep one's clothes clean and orderly is good training in methodical habits. The fundamental necessity is a systematic arrangement of clothes closets and bureau drawers. A poorly arranged and overcrowded closet spoils the work of the pressing iron. A small closet can be made to accommodate a great deal of clothing if the arrangement is good. This order being maintained, the care of clothing resolves itself into hanging clothes rather than throwing them down, airing, brushing, pressing, washing and ironing, and taking needed stitches.

The clothes closet. — The method of hanging garments in the dress and suit departments of the dry goods stores is a suggestion for closet arrangement. Either place a pole lengthwise of the closet an inch or two below the shelf, or screw several small nickel bars, similar to towel bars,

diagonally or horizontally to the under part of the shelf. From these more dresses, waists and coats can be hung side by side on hangers than can be cared for by the ordinary hook arrangement. There should be plenty of hangers, including the skirt hangers that keep the band straight. In arranging the clothes in the closet, keep them in a certain order, the best garments at one end, where they will not come in contact with the soil on those in daily use. These less used garments should be kept covered. Bags may be made of inexpensive material, with a buttonholed opening at the top to slip over the hanger hook, and arranged to close at the bottom with snap fasteners or buttons. This keeps out dust, and saves rubbing dress hems against any articles which may have to be kept on the closet floor. A worn nightdress may be mended and made into a cover.

Nothing but closed boxes should be placed on the closet floor. Shoes keep neater and last longer if placed in shoe bags. Sometimes the shoe bag may be fastened to the inside of the closet door, but this mars fine woodwork, and a better place is the side or back of the closet.

Brushing clothing. — Do not put skirts and coats away in a closet with the street dust on them. Lime and other substances in street dust have a dulling or even bleaching effect on colors, and often make ugly spots. It is hard to remove grease spots from clothing after dust has settled in them. Harmful bacteria are often carried into the home with the street dust. Brushing is therefore a safeguard, as well as a help in smoothing out wrinkles.

Airing. — Clothes worn next the body should be removed and aired near an open window at night, with the waists turned so that the shields dry in the air. In this way clothing keeps a fresh, clean odor, far more pleasant than any perfume.

Pressing. — Nothing gives new life to a suit or dress like

pressing it, and the satisfaction one feels in a newly pressed garment is worth the time it takes. Wool and silk demand special care in pressing. Woolen or silk material not made up is pressed on the wrong side, but skirts and coats generally look better pressed on the right side over a thick cloth. The ridges of folds and seams do not then appear on the right side so plainly. A damp cloth is laid on the material and the pressing done with an iron only moderately hot. A hot iron should never be used on a dry pressing cloth, nor allowed to rest long on a damp one. A heavy twilled cotton material, such as drilling, makes a better pressing cloth than muslin, as it is less likely to leave a smooth and shiny surface on the garment.

If serges become shiny from wear or pressing, the surface can be roughened by rubbing gently with fine emery paper. Another method recommended for removing surface shine is to dampen a piece of muslin in witch hazel, lay it on the material, and iron it until steam arises. Then place the cloth on the wrong side of the garment, and press until dry.

Care in hanging outer clothing as soon as it is taken off will keep it in shape longer than if it is thrown over a chair.

Washing and ironing. — Many of the smaller articles of dress can be washed out overnight, rather than be allowed to accumulate for the laundry. Silk stockings, for example, should always be washed after one day's wear, as perspiration weakens silk if allowed to dry in it, especially if the silk is weighted with tin salts. Cotton stockings also wear longer if washed frequently, after two days' wear at most.

Cotton crêpe underwear is liked by those who wish to change frequently without making their laundry too large. It washes easily and does not require ironing. Underwear made at home, of a soft but good quality of cotton crêpe, trimmed simply, outwears anything of this kind that the stores offer at a moderate price.

Flannels, in underwear or waists, need frequent washing, because of the secretions from the body which accumulate in wool or part wool garments. These, and silk waists and gloves, need special treatment in washing and ironing. For flannels, make a suds of a good white soap, or choose a soap especially recommended for wool. If the garment is much soiled, add a tablespoonful of borax to a gallon of water. Use warm water throughout; do not let the rinsing waters be cooler than the first water, as this would contract and interlock the expanded scales and cause shrinkage. Soak for a few minutes in the soap solution, then pass through the hands and squeeze gently. Do not rub or wring hard. Rinse free from soap, and dry in a warm place, but not near direct heat, which makes flannels harsh. Pull and stretch the article before it is quite dry, to soften it and overcome shrinking. Iron flannel waists on the wrong side while still somewhat damp, using an iron of moderate temperature. It is safer to put a cloth between the iron and the flannel.

Silk waists should be washed very much like flannels, using a good soap, and squeezing gently. Hard rubbing or wringing is liable to pull the weave in thin silks. Rinse well, roll in a towel, and iron on the wrong side while damp. A hot iron yellows silk and makes it stiff and harsh. Ribbons should be ironed under a dry cloth.

White silk gloves and stockings yellow if hung in sunlight to dry.

Laces and embroidered neckwear are ironed on the wrong side over a thick, soft cloth such as a Turkish towel. Pull out the points of the lace with the fingers. Fine laces are often dried without ironing, by stretching them gently into shape on a pad, and pinning down each point. Laces too fine to be washed may be cleansed by covering with some absorbent material such as powdered magnesia,

fuller's earth or chalk, and allowing it to remain twenty-four hours. At the end of that time shake out the powder, and repeat with a fresh supply if necessary.

A good quality of dress shield will stand repeated washing. Use tepid water and a mild soap. Brush the surface rather than rub with the hands.

Care of shoes. — Leather is costly, and it is worth while to make shoes last as long as possible by taking good care of them. The first essentials for long life in a shoe are a reliable maker, a good fit and a conservative style. Fancy shoes are short lived, as they become impossible when they show signs of wear. The fashion followed by some of wearing shoes of conspicuous cut and color with business clothes stamps them as persons of bad taste. Two pairs of every-day shoes should be kept on hand if possible, and alternated more or less; they will wear longer than if consecutive wear is given. Always keep boot-trees in shoes not in use. If boot-trees are not at hand, stuff paper in the toes and vamps. An oily dressing, one which needs polishing on the shoe, protects the leather, and should be applied every day or two. Rubbers add to the life of a shoe, for nothing ruins shoe leather more quickly than getting it wet. If the heels are allowed to get badly run down, the shape of the shoe is spoiled, and it looks old and shabby. Rubber heels when worn down on one side may be evened off by trimming them with a wet knife. Keep plenty of shoe laces on hand, and do not wait for a set to get gray and worn before replacing it.

Details. — Mend the tear or hole while it is small; if it grows big, the article may be rendered useless and have to be thrown away. Keep buttons, hooks and eyes, and snaps sewed on. Put new ruffles on old petticoats, and new linings in jackets. Protect the dress by wearing an apron while at work. Wash neckwear frequently. Corsets may be washed

or scrubbed in soap and water, well rinsed and dried in the sun, without becoming rusted or discolored. Keep neckwear, handkerchiefs and ribbons neatly put away in boxes. Have a box or pillow slip for the best hat. Clean waists keep fresh if laid in a box or separate drawer; the fancy ones should have the sleeves stuffed with tissue paper.

Special care of clothing. — *Protection against moths.* — Winter clothing needs protection against moths before warm weather comes. In the North the moths appear from June to August; in the South from late in the winter to the following fall. This is the common clothes moth, which in the larval stage is partly inclosed in a case or jacket. The eggs of the moth are laid on wool or silk, furs, feathers or carpets, or other material which is to be the food of the larvæ. It is in this latter form that the damage to clothing is done. The larvæ move in their cases along the garment, eating as they go. Before the eggs can be deposited on winter clothing is therefore the time to pack it away for the summer. Moths choose dark places for egg laying, so folds, pockets, insides of cuffs and other concealed parts of the garment are especially liable to be moth-eaten. To be sure that no eggs remain in the garment when it is packed away, it should be first thoroughly brushed and beaten out of doors. A sunny, windy day is best; blankets, furs and clothing should hang out for several hours on such a day. Soiled places attract moths, therefore grease spots and dirt should be removed. When the garment is thus prepared for putting away, the only other necessary precaution is to wrap it in such a way that the moth cannot penetrate the covering. A newspaper wrapping is protection enough, provided that it does not get torn, and that there are no openings in the wrapping where moths can enter. Tar paper is excellent, with the same precautions, and moth balls

scattered through the clothing give additional protection. When the bundle is ready for putting away, label it.

Removal of stains. — Professional dry cleaning, while expensive, is necessary at times. It is not always wise to try to clean as large a garment as a dress, nor to take chances with spots on delicate fabrics. However, there are many spots and stains that can be removed successfully at home, and the method of treating ordinary cases should be known by every woman.

1. Grease Stains. — If the whole garment cannot be washed with soap and water or soap bark solution, some solvent for the grease is necessary. Benzine, gasoline, naphtha, chloroform and carbon tetrachloride are all used for this purpose. The first three are highly inflammable. They are safe only when used in a room where there is no open flame of gas light or stove. If a small supply is kept in the house, the bottle or can should be tightly closed and stored in a cool place.

Always use sufficient of the solvent, gasoline for instance, for thorough cleansing. Any left over need not be wasted, but may be allowed to settle, and the clear liquid decanted from the dirty sediment. Two washings of badly soiled garments are always necessary, using enough gasoline each time for complete immersion.

In removing grease spots, care is necessary to prevent the grease spreading and leaving a ring around the margin. Place the cloth on blotting paper or soft absorbent material, and apply the gasoline, rubbing from the outside of the stain toward the center. For applying, use a piece of the same material as the garment, or at least the same color. Absorbents such as French chalk, talc, magnesia or fuller's earth do good service if used with the gasoline, either rubbed in with it in the form of a paste, or placed around the edge of a spot to prevent ring formation.

Vaseline spots will not come out in ordinary washing with soap or boiling, but need to be dissolved by gasoline, turpentine or kerosene.

Dry cleansing substances of a soapy nature are on the market. They are used with gasoline in the same way that soap is used with water.

Delicate colors may be affected by some grease solvents, and a test of the solvent's action on the fabric should be made on some unexposed portion. Chloroform, an expensive grease solvent, is the one least likely to remove color.

2. Fruit Stains. — Pour boiling water on the stain from a height. If fresh it will soon disappear, unless it is a peach stain. For this, or any persistent stain from fruit, use a bleach. Javelle water is usually used for cotton and linen; hydrogen peroxide for silk and wool. Any colored article would have its color removed by this treatment. Ammonia takes out some fruit stains, for instance, spots from orange or lemon juice, without injuring the color or texture of any fabric.

3. Coffee. — Pour on boiling water from a height. If the stain is old, soak in glycerin diluted with water or in a solution of borax, and rinse well after the stain is absorbed. Glycerin may be used on colored wool or silk.

4. Chocolate, Cocoa. — Sprinkle with borax and soak in cold water.

5. Iron Rust. — An acid is necessary to make the iron compound soluble. Hold the spot over a bowl of boiling water, and with a medicine dropper apply hydrochloric (muriatic) acid diluted with an equal volume of water. Rinse well after each short application. After the rust has disappeared, rinse in clear water, then soak for a few minutes in borax or ammonia water. Salt and lemon juice, "salts of lemon," and oxalic acid are also used for iron rust. "Salts of lemon" and oxalic acid are poisonous.

6. Paint or Varnish. — A fat or oil of some kind is an essential ingredient of paints and varnishes, therefore if turpentine, benzine or gasoline is used to dissolve the fat, the insoluble coloring matter in the paint will then brush off, and the spot disappear. Old stains are hard to remove. Soften these with amyl acetate, then remove with gasoline, or use equal parts of ammonia and turpentine in repeated applications.

7. Ink. — Inks vary so in composition that one method will not do for all cases. If the spot is on white cotton or linen, ink eradicators work quickly and effectively, or an equivalent treatment of alternate applications of Javelle water and oxalic or hydrochloric acid. Rinse the material thoroughly after the spot disappears. This method cannot be used for wool or silk, or on colored goods.

A safe treatment for any fabric is to soak the spot in fresh milk. If on white material, follow with oxalic acid, and a thorough rinsing in clear water.

Silk may be steeped in turpentine.

" Salts of lemon " may be used in warm water solution. Follow with thorough washing. A concentrated solution of borax is harmless and often effective.

In " Laundering," by Balderston, the following treatment is recommended for colors: Apply ammonium sulphide, wash with water, then wash with very dilute hydrochloric acid.

8. Blood. — Soak in cool water until the stain turns brown, then wash in warm water with soap and a little borax. After the stain has almost entirely disappeared, boiling will whiten the fabric.

If the material is thick, or cannot be washed, cover with a paste of raw starch, and renew as it takes up the blood, until the stain disappears.

9. Scorch. — Sunlight will remove scorch from cotton and linen material if the fiber is not damaged. Or try

rubbing soft bread crusts over the scorched place. Miss Rose in "The Laundry" recommends a paste made of the juice of two onions, one cup of vinegar, two ounces of fuller's earth and half an ounce of soap. Boil, and spread over the scorched surface. Let it dry in the sun, then wash out thoroughly.

10. Molds or Mildew. — Fresh spots can be removed with strong soap and water, followed by bleaching in the sun. Sour milk is also used. Old stains require a bleach, Javelle water being most effective. Colored fabrics are treated with ammonia followed by dilute acetic acid (vinegar will do), or the material is covered with a paste of powdered chalk and exposed to the sunlight. It is better to test a corner of the colored fabric before using the ammonia and acetic acid on the whole.

11. Grass Stains. — Soak in alcohol. Naphtha soap and warm water, milk, and hydrogen peroxide with ammonia are also recommended. Soap and baking soda may be made into a paste and allowed to remain on colored fabrics for some hours.

12. Iodine. — When fresh, the stain will wash out in soap and water, or dilute ammonia. An old stain, and medicine stains in general, may be soaked in alcohol. Moist starch applied will take up the iodine, which will be removed by repeated applications.

13. Machine Oil. — Use soap and water, or soak in turpentine.

14. Perspiration. — Soap and water, if the article can be washed. A persistent stain on cotton or linen can be removed by Javelle water. Balderston's "Laundering" suggests sodium hydrosulphite for silk and wool, or potassium permanganate and oxalic acid. Both these treatments remove color from dyed material, and redyeing is necessary.

A summing up of the agents used in stain removal shows

that they fall into four groups: Solvents, absorbents, cleansers with water, and bleaches. One or more substances in each of the following lists should be kept on hand in the household:

Solvents. — Gasoline, benzine, naphtha, chloroform, ether, carbon tetrachloride, kerosene, turpentine, alcohol.

Absorbents. — French chalk, fuller's earth, talc, starch, magnesia.

Cleansers with Water. — Soaps, soap bark, borax, ammonia, washing soda.

Bleaches. — Javelle water, hydrogen peroxide, "salts of lemon," oxalic acid, salt and lemon juice, hydrochloric acid, potassium permanganate, sulphur candle for sulphur fumes, sodium hydrosulphite.

Use of common bleaching agents.

Javelle water is a bleach for cotton and linen, but not for silk and wool. It is prepared by dissolving one-half pound of bleaching powder (so-called chloride of lime) in two quarts of cold water, and adding one pound of washing soda dissolved in one quart of hot water. Stir, let the mixture settle, and pour off the clear liquid. Use diluted with at least one volume of water.

Hydrogen peroxide may be used for any fabric. It does not harm wool, silk and feathers provided the bleaching is not continued too long. Feathers are left in hydrogen peroxide of full strength about one hour. A little ammonia or borax added to the peroxide aids in bleaching.

"Salts of lemon" is a potassium salt of oxalic acid. Like the latter, it is used for stains on cotton and linen. After using, the fabric should be rinsed thoroughly and dipped in ammonia water. Straw hats are cleaned with salts of lemon. Make a strong solution and rub it in quickly with a brush, then rinse well.

Hydrochloric acid is a strong acid useful for several cleans-

ing and polishing purposes in the household. With regard to clothing, its special use is to remove iron rust. It is not destructive to cotton and linen if brought in contact with them for a moment or two only and then well washed out. It should not be used on silk.

Salt and lemon juice resembles hydrochloric acid in its action. It is safer to use, but slower in effect.

Potassium permanganate is a safe and powerful stain remover, and is applied to vegetable fibers for almost all kinds of stains on white material. Make a weak solution, add a little oxalic acid to prevent the brown color left by the permanganate in neutral solution and rub into the stain until it disappears. Short applications and frequent rinsings are more effective than a long soaking in the permanganate.

Sulphur fumes bleach both animal and vegetable material, without injury to the fabric. The convenient method is to burn a sulphur candle in a confined space, in which the article, previously wet with water, is hung. The fumes of burning sulphur are dangerous if inhaled.

Setting colors. — There are several methods of setting colors in light summer fabrics. Salt is most commonly used. The material may be soaked for an hour or two before washing in a solution of a half cup of salt to a gallon of water, then rinsed free from salt before placing in the suds. A half cup of turpentine in a gallon of water is used in the same way, and may be more effective for some colors. Different colors require different treatment, although salt is the most generally effective substance for cotton dyes. Vinegar helps in restoring color to purples and blacks. Soak the material before washing, in vinegar water in the proportion of four tablespoonfuls to a gallon, or add the vinegar to the last rinsing water.

Dyeing. — It is worth while to look over one's wardrobe

occasionally to see what faded but otherwise good materials may be made serviceable again by dyeing. A white cotton corduroy skirt or a white crêpe de chine waist that has yellowed with wear dyes easily in an attractive light color. Faded tan stockings can be dyed black. Crêpe de chine ties, silk scarfs, ribbons, feathers and artificial flowers open up interesting possibilities of renovation. A good measure of skill can be attained with practice, if directions are followed, and one may soon learn to achieve artistic results. Shaded effects, tied and dyed work and batik are fascinating to try, and beautiful when well done. Suits, coats and other large garments are hard to handle and dye with even and fast colors, and might better not be attempted by the amateur.

Necessary Equipment. — An agate kettle large enough to hold the material easily, two sticks — cut broomsticks will do — for lifting and turning the article in the dye bath, and an agate cup and spoon for mixing the dye, are necessary.

General Suggestions. — First know the nature of the material to be dyed, whether all wool, silk or cotton or a mixture of two or more fibers. Wool and silk will take a cotton dye better than the latter will take a wool dye, therefore for mixed material a cotton dye is always chosen. This holds true if a wool or silk waist is stitched with cotton; the stitches will not take color from a wool dye, and will be conspicuous in the dyed garment. Purchase cotton dyes, therefore, for cotton, linen, artificial silk and mixed goods; wool dyes for wool, silk and feathers.

In choosing colors, do not be restricted to those in the dye packages, if the right shades cannot be found. A blend may be worked out to suit one's taste from combinations of red, blue and yellow. For example, red and yellow make orange; red and blue, violet; blue and yellow, green. Variations from the standard color may be made by alter-

ing the proportions of the ingredients. A little of the third color grays the combination. Most of the color houses which put dyes in small packages on the market issue books of directions, which contain lists of color combinations that can be worked out with their dyes. Work cautiously in blending colors, start with small quantities of the dyestuffs, and test the color from time to time on a piece of the material. Remember that a color is darker wet than dry, but that holding the wet material against the light will give the effect of the dry color. Remember too that the article will become deeper in color as dyeing proceeds, until the dye in the bath is exhausted. Boiling deepens the color in the material. If the article comes out too dark some color can be discharged by boiling in several changes of water.

If the material to be dyed is already colored, this is a factor to be considered in planning the new color. The new color must be darker, and it is well to select it in the same color order, for instance, a dark blue dye for a light blue dress; or else use the old as the foundation color for a blend. This is top dyeing, or the application of one dye over another. A dark green over a blue would give bottle green. Any color will dye black.

Prepare the material. Dyeing will not cover up grease or dust spots; the garment must be clean. If it is badly faded in places, the color should be evened as much as possible by repeated boiling in water to discharge the dye. Hems and folds should be ripped open and interlinings removed, as uneven thicknesses tend to produce streaking of the dye. It is best to take off trimmings, such as braid, or light places will be apt to show beneath.

A sample of the material, dyed in a small vessel, will show whether the color is satisfactory before committing the garment to the dye bath.

The dyeing operation should be carried on according to the directions on the dye package. Some judgment is necessary with regard to the proportion of dyestuff to the water in the kettle and the amount of material, unless the latter is weighed. If the dye is so concentrated that the fiber will not absorb it all, that which stays on the surface will cause crocking.

Use enough water to cover the material easily, so that it will always be immersed; do not crowd the goods in the kettle. Keep the material turned and stirred, to give even penetration to the dye.

After dyeing, to avoid crocking, rinse the material until the dye no longer colors the water. Follow by shaking the article until nearly dry. If hung up wet it is more likely to streak. Delicate fabrics should not be strained by wringing.

The length of time required for dyeing is usually stated on the package. It should not be shortened unless too much color is being taken up, as the full amount of boiling asked for is necessary for producing fast colors.

How to dye feathers. — Do not choose a fine plume for the first attempt at feather dyeing. A little skill must be gained from practice in order to keep the barbs or " flues " soft and full.

The feather is first washed in warm water and soap. Use a good soap, such as Castile. A little ammonia may be added. Rinse free from soap.

If the quill is not softened by the washing, soak the feather in warm water for a half hour or more.

Bleach with hydrogen peroxide if a light color is desired on a dark or stained feather.

Prepare the dye solution in an agate pan roomy enough to allow the feather to lie flat. Choose a wool dye, and dissolve in water to which a little oxalic acid is added (a

teaspoonful to a quart of water) or add from a half cup to a cup of strong vinegar to a gallon of water. Keep the butt end and the quill immersed at first, rather than the tip, until they have taken the color desired. The flues and tip will dye quickly; the quill needs a longer time. The tip may be dyed a different color from the rest of the feather by holding it out and dipping it in another bath, or shaded effects may be produced.

Remove the feather when the right shade has been reached, rinse it thoroughly, pat it with a soft cloth to dry it partially, and "starch" it. This is done by laying it flat and rubbing it in fine dry starch. After the starch is well rubbed in, shake and beat it out gently, until the feather is dry and the flues look soft and full. Another method is to work the feather in a milky mixture of starch and water, followed by drying and shaking.

Good straw in hats may be dyed when stained or faded. Wash free from dirt and soften by soaking in water. Use a wool dye, immerse the straw in the warm solution, and very slowly heat to boiling. Rinse thoroughly and press into shape with a moderately hot iron. Luster is given by putting the straw into a soapy water just before drying.

Fireproofing of clothing. — This is a precaution to be used particularly with children's clothes. Many children are needlessly burned while playing with matches or bonfires, especially when wearing Indian or cowboy suits, or outing flannel garments. Ammonium phosphate costs about thirty cents per pound. A pound dissolved in a gallon of water makes a solution in which garments may be soaked for five minutes, and become fireproofed until washed. Lace curtains, Christmas tree properties and other inflammable articles may be treated in the same manner. A strong solution of alum in water is also effective.

Remodeling and other economies. — There comes a time

with all clothing when neither mending, cleaning, pressing nor even dyeing can give continuance of use. The question then has to be decided whether to make over the garment or give it away. Under some circumstances it is better to give away. If one's time is worth a dollar an hour, it is foolish to spend much of it doing work worth thirty cents an hour. It is also not worth while to pay a seamstress to remodel clothing, unless the material is so good that the made-over dress will give almost as much wear as a new one. Quite often it does, giving even more satisfaction in its new form than in the original.

In remodeling, two useful fabrics are Georgette crêpe and silk. When an old gown is ripped apart, cleaned and pressed, breadths are often found for part of a skirt, the rest of which may be silk in panel or other effect. In the same way Georgette crêpe will help out in the waist and sleeves. Two dresses may often be combined into one. Two-piece skirts in wash material will sometimes make a one-piece skirt having flounces joined by cording. Children's dresses may be lengthened by covering the joining by braid, tuck or cording. Dresses and coats for older children will cut over into garments for the little ones.

Professor Davis, of the Oregon Agricultural College, has prepared the following suggestions concerning the use of worn materials for garment making:

1. Examine garments carefully and note how best they can be utilized and whether they are worth remaking.

Remember that remaking often involves more work than the making of new garments. One or more of the following processes is often needed:

Cleaning { washing. / removal of stains. / sponging, pressing.

Redyeing.

Ripping.
Very careful planning in cutting.
Combining of materials, if not enough of one.

2. In remaking, remember there is a saving of the price of material; also a conserving of material which otherwise would be wasted.

3. Do not put *unnecessary* labor on remaking. For example, if pieces of the old garment are large enough for recutting don't take time to rip seams; cut them off.

4. Have pieces clean and well pressed before beginning to cut. Cut garment apart previous to sponging, washing, removing spots, pressing, etc. It is much easier to work with smaller, flat pieces.

5. If remodeling is to be worth while, the finished garments must

a. Be *attractive.*

b. Have *wearing quality.* Consider this before beginning.

6. Choose patterns very carefully. Note the size and shape of pieces with which you have to work and choose a pattern the design of which gives pieces which will cut from material you have without conspicuous piecing. For example, if pieces are not long enough for skirt length, choose skirt with yoke, tunic skirt or two-tier skirt, any of which will require shorter lengths.

7. In remaking, piecing may often be successfully hidden under decoration if carefully planned. Plan to piece under tucks, pleats, folds, where braid is put on, insertion is set in, etc.

8. Place whole pattern on and *know* just how you are going to get whole garment from pieces before cutting any one piece.

9. In combining materials consider carefully color and texture of materials for attractive and harmonious results.

Every household has its particular economies in the use of textile material. The following may be suggestive:

Embroidered shirt waists can be cut down into guimpes.

Evening dresses will make over into evening waists, or parts of them can be used for trimming other dresses.

Collars for tailored suits may be cut from outworn pongee waists.

Short pieces of embroidery will make collar and cuff sets.

Collars and cuffs of two shades of linen, blue and white or tan and white, are attractive, and can be made from scraps.

In cutting out embroidered linen centerpieces, there are large corners left. These will give several rounds two or more inches in diameter, which can be made into doilies by crocheting a deep border. Doilies may also be cut from the strong parts of worn linen waists.

Tablecloths which are worn in the folds may be cut down into lunch cloths and napkins.

It is sometimes worth while to cut over into chemises nightdresses worn at neck and sleeves. Lay an old chemise or a pattern on the gown with the bottom hems even.

Men's silk shirts worn at the collar will make shirt waists with Dutch collars.

Men's cotton negligee shirts will cut over into shirt waists, aprons and laundry bags.

Gingham dresses will make aprons, or rompers for little children.

Make kitchen towels of flour bags.

Use worn underwear for floor cloths.

Let the children knit pieces of string into dishcloths and wash cloths.

Use worn stockings for dusters and shoe polishers.

Cut down strong parts of worn Turkish towels into wash cloths.

Keep a scrap bag. Do not burn or waste any textile material. Either sell it for paper rags or old woolen material,

or turn it into rag rugs. Cotton rags may be dyed and blended into beautiful woven rugs.

Sheets that are worn down the center may be cut and reversed, bringing the strong parts to the middle.

Use the best parts of outworn sheets for ironing board covers.

Keep all trimmings from old hats. Ribbons may be washed and dyed, flowers dyed or touched up with oil paints, velvets dyed or steamed, feathers recurled or dyed.

QUESTIONS

1. Give some general as well as individual reasons why clothing should be well cared for.
2. What harmful effect may street dust have on clothing?
3. What is the best method of pressing a serge skirt?
4. Give directions for washing and ironing a flannel waist.
5. What particular treatment will add to the life of a shoe?
6. Give a brief account of the clothes moth and its activities, and state how it may be kept out of clothing.
7. On what classes of fabrics are these bleaches used: Javelle water, hydrogen peroxide, oxalic acid, sulphur fumes?
8. Give the appropriate eradicator for the following stains: Grease, iron rust, mildew, machine oil.
9. Give some practical suggestions for the preparation of material and dye bath in home dyeing.
10. What economies in the use of textile material can you add to those given in this chapter?

Questions and Problems for Further Study

1. Look over your wardrobe and consider whether by redyeing you may get new wear out of waists, stockings, neckwear, hat trimmings, etc.
2. Find out by test whether salt or vinegar is better for setting the color in samples of pink, lavender, pale blue, pale green and dark blue cotton dress materials.
3. With reference to shrinkage, is it better to buy a loose weave or a close, firm weave for flannel waists? Make washing tests to determine.

CHAPTER X

ECONOMICS AND HYGIENE OF CLOTHING

A. Economics

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Economics

Guidance in dress. — People are divided into two classes in the matter of purchasing dresses or other outer garments: those who buy on the impulse of the moment; and those who think out just what they need before going to the stores. The first way is wasteful and disappointing. Often the dress that is bought because it appeals to the fancy in the store proves to be an error in judgment when it comes home, either because it does not fit in with the rest of the wardrobe, is too expensive, does not fill a present need or is unbecoming to the wearer. Most of us possess clothing which we would never have bought if we had considered its purchase more carefully. It hangs in the closet, too good to give away, and not right for wearing.

The woman who plans beforehand looks over her clothing to see what new articles she must have for the season's wear or for the present need. When her list is made, she apportions the money she can spend, decides what fabrics, colors and styles are suited to her and to the rest of her wardrobe, and with her plan in mind, purchases with the least waste of time and money.

From a point of view other than economy of time and money, the purchase of apparel should not be a thoughtless and haphazard business. It is not a wrong emphasis on material things to say that every one may properly study to be as well dressed as circumstances warrant; but "well" dressed should mean appropriately and becomingly, not expensively nor according to every passing style. Becoming

dress need not be the most expensive, but it must be carefully planned so that it is right for the wearer. If each girl or woman will look upon herself as an individual type, to be studied in relation to the styles and colors that are suited to her personality, she will realize how foolish it is to follow blindly the prevailing modes as each appears, simply because they are the fashion. How curious and grotesque a " fashionable " garment looks upon some people !

The best dressed girl or woman is the one whose costume is so harmonious in itself, and so suited to her individuality, that the details of it are unnoticed, and only the rightness of the whole is remembered. Let it be repeated that good taste will achieve this result where money alone will fail.

In choosing a costume, some of the guiding factors in selection are its appropriateness, color harmony, design, comfort, durability and cost.

Appropriateness. — A gown may be beautiful, artistic and becoming, yet be lacking in this first requirement of good taste. Appropriateness is judged according to whether the costume suits the occasion, the wearer and the rest of the wardrobe. Social customs have decreed certain types of dress for certain occasions. One feels comfortable in a tailored skirt and shirt waist for business wear, but the same dress might take away from one's peace of mind at a formal reception. Unfortunately the sense of appropriateness seems to be lacking in those who get the last wear out of bedraggled evening dress at school or business. The sense of being appropriately clothed for the occasion or occupation reacts on the mental attitude to give poise and dignity to the wearer, and a sense of efficiency.

If the amount of money that can be spent on clothes for social functions is small, it pays to put it all in one gown of good quality, quiet in color and simply made. The wearer will get more satisfaction from such a dress, and give

more pleasure to others, than in two or three gowns of cheap material which may soon become conspicuously shabby.

Age should be considered in choosing a garment. Nowadays the grandmothers and the grandchildren too often follow the same style regardless of suitability. Young girlhood loses its youth and charm when it cannot be distinguished from its elders in the fashion of its clothes. The extremes in dress, in the arrangement of the hair, and in the touched-up complexions, are so unbecoming to the young and the old as to be repulsive. A young girl is twice as attractive in a simple dress which makes a setting for her youth, as in one which is elaborately fashioned.

Simplicity and modesty, for the young or old, are ideals which women should hold as marks of their womanhood. Dress is an indication of character quite as much as the face. Professor Patten, of the University of Pennsylvania, says that dress is the essence of moral progress, and that a return in moral qualities is yielded according to the type of dress. The less advanced woman, spiritually, clings to a type of dress which makes the lower appeal; the woman of higher morality knows that whatever carries the emphasis to her face gives her a spiritual impress, therefore she brings the striking colors or contrasts near the face or on the hat.

Quite important in choosing a gown is its suitability to the wearer's environment. Mothers who wish their daughters to be as well dressed as any of their schoolmates often carry their ambition too far, and need to learn that it is no kindness to the daughter to dress her beyond the family means. The girl learns to put too much emphasis on fine clothes, and insists on having them — one of the worst of evils in its insidious undermining of character. Every girl, especially of high school age, has seen unhappiness inflicted on the plainly dressed student by the supercilious attitude toward her of some better dressed classmate. The girl

of true American spirit will use her example and influence against such snobbishness.

Color harmony. — The first essential in choosing a color for a dress is its harmony with the characteristics of the wearer. A dark red dress is a charming setting for a girl with clear skin and dark hair and eyes, but it makes a florid complexion more prominent. Vivid colors accentuate any defect of figure or coloring, and ought to be avoided by stout people. They seem in their right place when found in sport clothes for young people, yet even here they need to be chosen with taste. Recent tendencies in art have brought about changes in public taste, and striking designs and color combinations have become popular. It takes more knowledge of color harmonies than was formerly necessary to discriminate between the good and the bad.

A dress chosen in its material or trimming to repeat the color of the eyes is usually becoming. Auburn hair gives an opportunity for beautiful effects in color harmony. Bronze and other shades of brown are often more effective with this color of hair than the traditional greens and blues.

If one cannot have more than one or two hats and outer wraps, the dresses should be bought with reference to these, or vice versa. A purple dress does not harmonize with a blue coat and a red hat. In winter especially, it is economical to have the important parts of the wardrobe in one color scheme, in order to make combinations possible.

Design. — When design is considered, most people need to be treated as individuals rather than belonging to a type or general class. More can be learned about becoming line and design from a full length mirror than from a fashion sheet. That is to say, the proportions of each figure should settle the fashion of the dress, regardless of whether it is in accord with the prevailing mode. Even if short skirts are in order, short figures look better in longer ones. The

person with the extreme figure, either thin or stout, tall or short, needs to adopt the costume design which will not accentuate such characteristics. Broad stripes, large plaids and other conspicuous patterns exaggerate short, stout figures and make them look grotesque, while long, unbroken lines and no fullness are equally bad on thin figures of unusual height. The eye follows the prevailing direction in the line or design of a gown; the principle to be followed, therefore, is to lead the eye away from defects in the proportion of the figure. A broken effect in the line of the skirt, such as a flounce, and breadth in the shoulders and sleeves carry the eye in the horizontal rather than the vertical direction, and take away the effect of height. An outer wrap of medium length is more becoming to a tall person than an extremely long or short one. The Eton jacket effect is unbecoming to such because it accentuates the length of the figure from the waist down. One-piece gowns with trimming effects that give length are becoming to the short person.

An artistic arrangement of line can make an art composition of a dress as well as of a drawing. The design should have unity and balance. Lines that are jerky or that lead nowhere are irritating, but a smooth sweep of line gives satisfaction to the eye. Just as in a painting a good effect in composition is produced by causing the eye to travel from the central object to its echo, so in a dress a leading effect in color or design in one part may be repeated with less emphasis in a less conspicuous part, such as in the yoke, collar or cuffs. The value of this treatment may be seen by studying Corot's " Spring."

It is well to be conservative about adopting striking innovations in costume design. Since some of these have a brief season's vogue, next season the garment is conspicuous.

> " Be not the first by whom the new is tried,
> Nor yet the last to lay the old aside."

Comfort. — This is a consideration that is often overlooked in planning a dress. The style is first thought of, and comfort is taken more or less for granted. The past twenty years have seen eras of wholesale discomfort attendant on certain styles, *e.g.* high, tight collars, sleeves that bind, waists that pinch and skirts that hobble. If one chooses, it is easy at the present time to select fashions that break none of the rules of hygiene. Comfort may be enjoyed in skirts that are sensible as to length and fullness, one-piece dresses may give ample room at the waist and suspend the weight from the shoulders, and the low neck, if not extreme, is comfortable and hygienic.

Durability. — As materials soar in price, the question of durability becomes more important. In this the tables of materials at the ends of the chapters on cotton, linen, wool and silk will be helpful. For example, it will be seen from the list of cotton fabrics that batiste and organdie are sheer cotton materials used for dresses, of about the same width and range of price. Batiste launders well, but organdie loses its finish and beauty. In silk, chiffon cloth is more durable than chiffon, but Georgette crêpe is more lasting than either, being stronger and capable of being washed. Foulard of the same price as taffeta would probably have two or three times the wearing value.

Where different grades of the same material are found, it pays to buy a good quality even if the initial expense is high.

The cost of clothing. — Cost is for most people a determining factor in the choice of clothing. Many are forced by the limitations of their means to choose the plainest and most serviceable garments, often at some sacrifice of beauty and artistic effect. Careful planning ahead is of great assistance in making a little money go far for clothing expenditure. It eliminates the waste of buying the wrong or

unnecessary thing, so that the articles that are bought represent a thoughtful and judicious outlay.

It is a helpful plan to keep expense accounts, and from them to determine the amount that can be spent for clothing. Experts agree that a fair division of income allows about 15 per cent for clothes. According to this, a woman with a yearly salary of $1000 would be justified in spending $150 on clothing and incidentals of dress. As times change, however, and prices of food and shelter increase out of proportion to the salary, there is a tendency to save on textile material, and probably 12 per cent approximates more nearly the expenditure of most wage earners at present.

The clothing budget. — The best method of planning the distribution of the money allotted for clothing is to make a list or budget of all the required articles of dress and apportion the fund accordingly. The following is a suggested basis for apportionment:

Hats, coat, suit, sweater, shirt waists . .	53 per cent.
Negligees, underwear, corsets	14 per cent.
Shoes, hosiery, rubbers, umbrella . . .	20 per cent.
Gloves, neckwear, sundries	13 per cent.

A budget is planned usually to cover three years in advance, so that such garments as outer wraps may be carried over through their period of wear. The division of the clothing allowance shows just how much may be spent for the larger articles of dress. The budgets for each of the three years will not total the same, as in one of the three, at least, there will be an extra expenditure for a winter coat, sweater, or similar garment representing a considerable outlay but a long period of wear.

Ready-made and homemade garments. — For the busy woman who cannot afford the time to select material and plan garments, buying clothing ready-made is an easy

solution of the problem of dress. This is its great advantage. Another point in favor of the ready-made dress or suit is that its becomingness and suitability can be studied and compared with other models before purchasing, whereas with the homemade dress, although the finished product may prove to be disappointing, it usually has to be worn. Again, in ready-made clothing the choice of style and material is so wide that one often finds artistic designs and color combinations beyond the power of the average dressmaker to originate.

To balance the good features of buying clothing ready-made are these considerations:

It is difficult to find a perfect fit. Alterations are expensive and sometimes spoil the effect of the gown; for example, shortening a skirt which depends upon long lines for its grace and symmetry of parts.

As a rule, the cost of ready-made dresses is high, considering the grade of material and the workmanship. The garment might cost more if the same material were made up by a first-class dressmaker, but the difference in workmanship would give it longer life.

Those who wish conservative styles find it hard to choose a ready-made dress at a reasonable price. Each season sees the stores stocked with models representing the latest and often the most extreme and transient of the fashions. These are comparatively cheap; the exclusive and artistic dresses which good taste would choose can be found, but are often quite out of the reach of the limited pocketbook. The transient nature of these extreme styles makes the wearer of them conscious of being conspicuous if she has to wear the garment the following season.

The ideal way of solving the dress problem is to possess fewer dresses, but buy excellent material for these and have them made by a dressmaker who knows how to plan gar-

ments that are right for the individual and of a style that will look well for several seasons. Such dresses outwear the ready-made ones, and give satisfaction as long as they last.

Many girls and women have taste and ability in making their own dresses. This allows for a number of garments at a small total cost, and is an admirable plan provided the individual does not confine herself to her sewing to the impairment of her health. The girl who is in school, office or other business place in the daylight hours would better spend a part of each twenty-four hours in healthful recreation than in constant sewing, even though it means a scanty wardrobe. If she makes her own dresses, good sense should lead her to choose the simplest and easiest of the suitable styles.

The economics of textile production. — Since women are the largest buyers of textiles, they have a measure of responsibility for the hours, wages and working conditions of laborers on textile material. It devolves upon them to understand something of the economic relation between them and the human factors, as well as the mechanical, in a field of production which they so largely create and control. Unless the manufacturers have the coöperation of the consumer, it is difficult for them, under the stress of competition, to maintain a high standard of working conditions in the production of some kinds of textile goods.

The consumer's relation to the producer. — A large part of the buying public demands cheap articles of wear, regardless of how cheapness has been brought about. Such goods can be produced only under a system of cheap labor on cheap materials. The most profitable type of labor for the manufacturer, and the one which reacts most in the cheapening of certain classes of goods, is the work which is put out of the factory to be done in the homes. Here

the labor of all members of the family can be utilized, without reference to age, factory law, or living wage, and the employer is under no expense for factory maintenance nor for the payment of wages in dull seasons. This is the sweating system, and the homes where the work is done are called by the suggestive name of sweat shops.

The sweating system. — The evils of the sweating system are long hours, low wages, unsanitary conditions and the spread of disease, the "speeding up" process, lack of inspection, and the social effects of the system.

The hours of labor in the home are impossible to regulate. The inadequate pay, the irregularity of employment and the rush in busy seasons create a necessity for long hours of toil, in which little children participate. Seventy-four per cent of the artificial flower supply of the United States is made in New York City, more than half of these flowers in tenement homes. Within the past two years prices such as the following for this and other lines of goods have prevailed:

For putting artificial berries on stems, one cent per gross. The average daily earning is ten to fifteen cents.

For making artificial violets, five cents for six bunches of twenty-four flowers each.

For Irish crochet yokes, nine cents each, out of which the worker pays two and one-half cents for thread.

For finishing overcoats, six cents a coat.

For making underwear, seventy-five cents a dozen for nightgowns, twenty-two cents a dozen for corset covers.

Because of harder conditions of living at the present time, more work is being taken into tenement homes, much of it created by the demand for increased production of articles for war supplies or related uses. Recently little children have been preparing lapel-button American flags at three cents per gross.

The tenement homes where work of this character is done are licensed by the Bureau of Factory Inspection, but at present there is an average of one inspector to one thousand houses, and a house often receives inspection only once in a year. During that time many contagious diseases may run their course. Two blocks of these licensed houses in New York City are reported to have the dirtiest homes, lowest standards of living, and the highest disease and death rate of any section of the city. The danger to the community at large is so real that the New York Factory Investigating Commission has had a law passed prohibiting work for a factory in tenement homes on food products, dolls or dolls' clothing, and children's or infants' wearing apparel.

Although there is a law which forbids children to do factory work in a tenement home, owing to the lack of adequate inspection it is practically unenforced.

The remedy for the sweating system is to abolish it, and do in the factory, for a living wage, the work now done in the tenement homes. A business which exists in part on labor which is practically unpaid for, much of it child labor, is on a wrong economic basis, and a menace to society because of the evils it fosters. The National Consumers' League has worked for twenty-five years to bring about better conditions of labor in this field, and a living wage for all women workers. It has been instrumental in having laws enacted which limit the hours per week of women workers in factories, and which in a number of other ways aim to improve working conditions for the employee and to safeguard the public. It seeks to arouse public sentiment to the need for further legislation, and a more adequate enforcement of existing laws. For the protection of the consumer, it affixes a label to ready-made articles which are manufactured in factories under sanitary conditions.

At present this label is not a guaranty of right conditions of production as to hours and wages, except that no children under age are employed, and the state labor laws are otherwise obeyed. There is, however, a " white list " of business places such as department stores, prepared by the League, to which the consumer may refer if she wishes to give her patronage to those stores which give their employees fair treatment.

CONSUMERS' LEAGUE LABEL

FIG. 71. — CONSUMERS' LEAGUE LABEL

Frequent style changes.— This is an economic evil for which the consumer and the designer must share the responsibility. Rapidity of style changes reacts on the manufacturer to put his industry on an unsettled basis. He cannot use slack inter-season times to make goods ahead of the demand, for at any moment new fabrics or fashions may arise which will have sufficient vogue to crowd the old aside. Consequently there are long periods of inactivity, alternating with times when the speeding-up process, down to the sweat shop, is at its height. Nothing is more unsettling to labor than this. The designers not only create new styles for every season, but an endless variety of styles, to satisfy buyers who demand exclusive models for customers who do not wish to see their suit or dress duplicated on another person. Each change in pattern calls for a new price agreement with the piece workers, and much loss of time is involved. Moreover, the styles for one season differ so from the next that any stock left on the retailer's hands is more or less a loss, and prices of goods are higher in consequence. Since the fashion magazines go all over the country, even the country store must get in the new fabrics and designs, though there may be a good stock on hand of the superseded styles. This economic waste is

connected with clothing for women rather than for men. When it is necessary to exercise economy in the use of raw materials so that military needs may be met and mills not be overburdened, it becomes plain that a change should be made toward restricting and simplifying styles in fabrics and garments. We must realize, too, that the same considerations should be applied to the long period of recuperation which must follow the war.

Ethics of shopping. — There are some bad habits into which a large part of the shopping public has fallen, which cause considerable loss, often to the merchant, and quite as often to the purchaser.

Bad shopping habits. — These are the stretching of the delivery and return privileges, late shopping, and, in some cases, buying at bargain sales.

Stretching the delivery privilege. — The delivery of all merchandise, both of foods and dry goods, has become so universal, that even the smallest packages are seldom carried. There is some justification for this, for often in large department stores more time is consumed waiting for the return of the wrapped package than the customer can afford to spend. Shopping devices such as " take " transfer cards are found in some stores, and for those who purchase in several departments they eliminate this loss of time. The packages are ready to be taken within a few minutes of the time of the last purchase. If the stores could minimize still more the time consumed in waiting for a single purchase, more parcels would be carried home. For delivery sales, the stores wish their patrons to use transfer cards, even when making two or more purchases in a single department. This system provides that the purchases are collected in one package for a single delivery. Otherwise more than one delivery is sometimes made. The cost of delivery may be said to average ten cents for each package.

At present the maintenance of the delivery service increases the cost of merchandise, and is paid by all alike, whether parcels are carried or not. If it were feasible, it would be fairer to the consumer to charge a net price, and add a charge for delivery. However, any saving to the merchant works out in time, through the laws of competition, to the benefit of the consumer. An investigation by the Department of Commerce at Washington reveals what delivery costs amount to. A number of retail stores in Washington gave figures which showed that for sales amounting to $38,000,000 in round numbers, the cost of delivery amounted to $2,000,000, making it necessary to add about five per cent to the selling price of the stock.

Stretching the return privilege. — The bad habit of returning goods is entirely within the power of the purchaser to correct. Many shoppers show a lack of conscience amounting to dishonesty in this matter. It is not uncommon for a so-called purchaser to order an expensive article sent home, with the definite plan of wearing the article on one or two occasions and then returning it. The store usually takes it back even though damaged, rather than lose a customer or its reputation for generous dealing. Dishes and furniture are obtained in the same way for a single occasion or for longer use, and are sometimes sent back so late in the season that their sale is lost because the demand is over. The stores have had to protect themselves as far as possible against such dishonesty by affixing labels in prominent places to wearing apparel, and refusing to accept the return of goods from which the label has been removed. Many stores now limit the period in which goods may be exchanged or credited to a very few days. The amount of stock which is out on approval from a large store in a single day amounts to thousands of dollars, of which perhaps one-fifth will be sold. The merchant must keep

overstocked to offset this, in order to have a full line of goods in the store. In some classses of goods in which there is a shortage of raw materials, the depletion of stock from this cause prevents the merchant from ever having a full line to display. It is a conservative estimate that the cost of delivering, calling for, and redelivering, when an article is exchanged, makes a spool of thread, for example, cost 20 cents.

Late shopping adds considerably to the running expenses of a store, and incidentally to the cost of goods. Stores are crowded during the middle and latter part of the day, and almost empty in the early morning hours. More than 75 per cent of sales are made after two o'clock. The merchant must keep a larger sales force to meet this congestion than would be necessary if the sales were evenly distributed through the day. Those who shop at 9 A.M. instead of 3 P.M. get better attention, have better opportunities to make selections, and lessen by so much the later strain on the salespeople. Helping to equalize the day's sales will thus prove of immediate benefit to the purchaser, and of eventual benefit in the improved quality or the lower prices it will enable the merchant to offer.

The Christmas rush. — The dread with which all salespeople regard the Christmas season is an evidence of the thoughtless attitude of the general public toward the welfare of this large group of workers. The eleventh hour rush for Christmas gifts keeps some stores open until 10 P.M. or even midnight for the week before Christmas, and, even in the best conducted establishments, sends the employees home in an exhausted condition night after night.

Lack of consideration for salespeople. — Many women are indefatigable shoppers, but small buyers. Without intending to purchase, they inspect a complete line of goods and then walk away, blind to the fact that they have pre-

vented the saleswoman from making other sales. This is the more discouraging to the saleswoman if she is working on a commission basis. A number of stores allow commissions to their sales force in addition to salaries, on all sales beyond a certain amount. Taking the employee's time without intending to purchase, or nullifying a sale by making a careless purchase and returning it, is equivalent to reducing her weekly wage.

Another point which the thoughtless shopper overlooks is this: After she has engaged the time of a saleswoman for a considerable period in showing goods, she may go away without purchasing, but return later and give her order to another girl at the same counter. The first girl really made the sale, and should receive the order.

People who do not fail in courtesy elsewhere often forget to be courteous to the girl behind the counter, yet resent any irritability on her part. Fair treatment usually brings fair treatment in return. For example, if the customer wishes to defer purchasing until she has looked at the same goods elsewhere, a frank statement of her intention is better than concealment, and will almost always be met by willing service.

Bargain sales. — Shoppers are becoming educated in the matter of bargain sales. The bargain counters do not have, as a rule, the besieging crowds of former times. Still, there are hundreds of shoppers who cannot resist the lure of the advertised bargain prices.

The great fault with the bargain sale is that it induces purchasers to buy articles for which they have no real need, simply because they are supposed to be cheap. Often the merchandise is really marked down considerably; quite as often the sale offers a few real bargains mixed in with stock which is not worth any more, at most, than its selling price. As an illustration, in a certain store an article of

unique pattern, the only one of its kind in stock, was put on sale at Christmas at a high valuation. After Christmas it was marked down considerably, but not sold. Two months later it appeared in a bargain sale of that class of goods at its Christmas price. No one should be drawn into bargain purchasing who is not thoroughly familiar with the regular values and prices of the merchandise on sale.

Good shopping habits. — *Seasonal sales.* — On the other hand, it is a matter of economy and efficiency to take advantage of seasonal sales. Reliable stores offer these sales at stated times to avoid carrying over a heavy stock to the next season. Some of these are the regular white goods and furniture sales, and the offerings of dresses and suits at the end of seasons. The housewife who looks ahead and purchases her year's supply of household linens and muslins at these sales is applying good business methods to household expenditure.

Remnants are frequently put on sale at reduced price. To be sure that it is economy to buy a remnant, the regular price of the article should be known; with yard goods it is sometimes only a cent or two higher per yard. In this case, if there is a little more material in the remnant than is needed, it is extravagance to buy it. Good values are often obtained in upholstery remnants. Small pieces of brocade, tapestry, damask or cretonne, large enough for a chair or a pillow cover, frequently can be bought at half price.

Buying based on knowledge. — The intelligent shopper knows values. She knows the current cost of the satisfactory grades of dress materials, household muslins and linens, and how to judge the real worth of material; she knows what materials wear best for certain purposes, and what ones to avoid; what colors are tub proof and sun proof, and the materials that shrink or that hold their

shape. This knowledge brings the largest possible return for the money invested. It requires years of study and experience to become an expert purchaser.

It is a time-saving plan to learn in what stores certain goods can be purchased to advantage, and form a habit of going to a given store for a particular line. In this way a customer becomes known to the sales force, which in dealing with a large store is a valuable asset to the shopper.

Hygiene

Importance of dress hygiene. — Clothing is too seldom chosen with a conscious regard to its influence on body health. Fashion, price and attractiveness are the dominant factors in selection. Yet it is no more rational to expect an unwisely clothed body to be in perfect physical condition than it is an ill-nourished one. The body may tolerate improper food for a long time; the penalty for clothing it improperly is often swift and sure. Apart from this direct connection of careless or reckless habits in dress with disease, is the further consideration that clothing has a constant influence on such normal functions of the body as heat regulation, excretion, and motion.

Clothing and body heat. — Food is the fuel which the body engine converts into energy, much of it in the form of heat; clothing conserves this heat. Good health depends upon the maintenance of an even body temperature of about 98 degrees. A variation of a few degrees either way often means death. Among civilized men, clothing is the principal means of keeping the body at even heat. It does this most efficiently when it makes a covering of equal warmth throughout, adapted to temperature conditions. This equal distribution of warmth is important. If the covering is insufficient in warmth as a whole, or leaves

portions of the body exposed to cold, nature has to make two kinds of heat adjustment for our safety. The physical adjustment is accomplished by sending less blood to the skin, in order that less heat may be lost by radiation and conduction, and by a checking of the rate of perspiration. The chemical adjustment means increased oxidation in the body tissues. In other words, the body is consuming more fuel, just as a furnace must in order to send out more heat. This extra fuel supply for the body, if not obtained by increasing the food eaten, is furnished at the expense of body energy. Having learned to depend on clothing, we should make it adequate to the body's needs. The choice of clothing from a hygienic standpoint demands an understanding of these facts and a mind superior to the dictates of fashion. The fashion which decrees straw hats and low shoes in January, and furs and velvet hats in August, is not concerned with health in dress.

The hardening process. — The fallacy of the "hardening process" is responsible for some violations of the laws of hygiene in modern dress. No doubt one may make a practice of dressing too warmly, so that the vessels of the skin are kept relaxed and not in condition to meet sudden exposure. On the other hand, women and girls appear on the streets in winter with thin-soled low shoes worn without rubbers in snow and sleet; ankles exposed in the thinnest of stockings, and neck and chest bare to the cold. The body cannot be kept in firm health by a kind of exposure which lowers its working efficiency and leaves little margin of safety in time of need. This method of hardening means the survival of the fittest. Even the fittest come through a little less fit.

Little children are quite commonly made victims of the hardening process. As soon as it is spring by the calendar, they can be seen in low socks with bare knees in the raw winds

of March and April. The only time for an exposure of this kind is a summer day. The joints need extra covering rather than none, because they are areas of slight heat production. The ill effects of this system of dressing children may not be seen at once except in a lowering of body tone, but it may lay the foundation for disease later. Children need as warm clothing as the normal adult, because their surface area is great in proportion to their size, and all their reserve energy is required for growth.

Garments for winter wear. — In steam-heated houses and public buildings the temperature in winter may be fifty or sixty degrees higher than that out of doors. Such a condition requires a special adjustment of clothing. Most people, except little children and the aged, find it best to make their indoor clothing for winter correspond to the summer temperature in their houses, and to depend upon heavy outer wraps for protection against the cold outside. At least it is not well for active people who are indoors most of the time to wear both under and outer garments of heavy material in winter, since the relaxing effect of excessive perspiration makes the wearer more subject to chill when going into the outer air. This is a risk incurred by those who keep on heavy cloaks and furs in overheated trains or public buildings, or who in light evening dress go from a hot room to the outer air to cool off. Many colds could be avoided if wraps were taken off and put on with some regard to temperature conditions.

In winter, the function of the outer garments is to keep out the cold; of those next the skin, to be non-conductors of the heat of the body. Because of the difference in function, a different type of fabric is required for each. The outer garment should keep the wind from passing too freely to the body, therefore its texture should be close. A close weave, such as broadcloth, keeps in the air warmed by

contact with the skin; a loose weave allows air currents to enter freely and cool the body. For this reason, a sweater suit is not the right kind of protection for a little child on a cold windy day, but with a light-weight, closely woven coat over it the combination is good. The leather hunting jacket lined with fur sums up the principle of protection in outer garments. Two light-weight coats will be warmer than one heavier, because of the air held between them.

The main requirement for a garment worn next the skin in winter is that it shall have a weave open enough to hold air in its meshes, but not so open as to allow too free circulation of air. Air not in motion is a poor conductor of heat, so if held in the meshes of an open weave it helps to hold in the body heat. Furs are warm because they hold so much air, and wool feels warmer than other fibers for the same reason. Good ventilation for the skin is also provided by the moderately open mesh.

Garments for summer wear. — Underwear for warm weather may be of lighter weight and more open weave than that for winter. The principal difference is in the outer dress, which should allow free circulation of air to the body. Both cotton and linen are good conductors of heat in smooth, close weaves, the latter feeling especially cool in this form. Linen allows more rapid evaporation of perspiration than any other material, so in a smooth weave may cool the body too rapidly and cause a chill. Cotton gives more heat protection than linen.

Choice of fiber. — In choosing underwear, the open mesh is a more important consideration than the kind of fiber. All fibers acquire a feeling of warmth in this weave. However, there are some differences in the properties of the fibers themselves that have a bearing on their hygienic value.

For babies, young children, old people, and all those who exercise and perspire little and feel the cold, wool in under-

wear is desirable because it is a non-conductor of heat. Even in these cases, however, it may well be mixed with one-fourth or one-half cotton or silk. Its drawbacks for the average person are many. It tends to overheat those who exercise, then when excessive perspiration follows it does not allow it to evaporate, but soaks it in until the garment feels clammy, and a chill is likely to follow exposure to a penetrating wind. Another disadvantage of all wool underwear is that it will shrink with laundering, the fabric becomes felted and boardlike, and the openings of the weave disappear. In this form it increases perspiration and absorbs it, without giving proper ventilation. Since wool can hold much moisture in its pores, the fibers become clogged with the secretions of the skin, and the garment is then difficult to cleanse. A mixture of wool with some cotton, or wool and silk, shrinks less and stays soft and open. The initial cost of silk and wool underwear for babies is high, but if stretching frames are used for the shirts, bands and stockings, the garments last much longer than those from all wool, which even if carefully laundered soon become too small.

Silk has good properties for open mesh underwear. It is cleanly, absorbs perspiration but does not retain it, and is a poor conductor of heat. Its cost, the care that must be taken in laundering it, and its clinging smoothness take away somewhat from its popularity, except in combination with other fibers.

Cotton and linen in open weave have heat-conserving properties which in close weave they do not possess. Cotton holds more air than linen, and does not lose moisture by evaporation so readily. It allows perspiration to pass off rapidly enough for a feeling of comfort, without chill. Unlike linen, it is woven into fabrics having a finish and a feeling of warmth and softness like that of wool. As it is easily

procured in suitable weights for both winter and summer wear, most people find it satisfactory for all-year garments.

Clothing and perspiration. — The average grown person gives off at least three pints of water per day as sensible or insensible perspiration. The clothing takes up most of this, in addition to oily secretions from the sebaceous glands. All this will clog the pores of the skin if it is not absorbed and discharged readily through the clothing, and it follows that the blood cannot make full use of the skin in the normal way as an organ of excretion.

As has been said, wool will hold a great deal of moisture, and it dries slowly. Silk is almost as capable of moisture absorption as wool, but it dries more quickly. Cotton and linen take up about the same amount of moisture — only about one-fourth of that which wool absorbs.

Clothing and a clean body. — Wool is the least cleanly of the fibers, because of its nature. It holds sweaty and oily secretions, and more bacteria can be found on its surface than on any other material under the same conditions. It is not easy to sterilize it and at the same time keep it soft and unfelted. Bacteria cannot be removed by the ordinary laundering of wool in tepid water and a neutral soap; strong soaps and boiling water cannot be used. Cotton is not naturally so clean as linen, as it has not the smooth, oil-free fiber of the latter. Experiments have shown that in exactly similar conditions cotton will collect two or three times as much dirt and bacteria as linen. However, it launders easily, can be sterilized without harm, and therefore with frequent changes is sanitary.

Frequent changes of underwear are quite as necessary as frequent baths. Little children especially are liable to disease arising from insanitary conditions, and need the help that a clean skin and clean clothing give toward vigorous

growth. The flannels that a baby wears next to its skin should be changed and washed every day.

Outer garments, though they may not come in contact with the skin, need much attention as to cleanliness. It is a pity that most of our winter dresses are not washable, but they can at least be frequently brushed and beaten free from street dust. Occasional dry cleaning of these garments is worth while.

Clothing and an unrestricted body. — A woman or girl can never expect to be really well if her clothing is habitually tight on any part of her body. Tight corsets, shoes, and collars bring about sure results in the development of local or general disorders. Freedom of motion for all the muscles of the body is nature's requirement. Especially will a woman suffer sooner or later if she wears an ill-fitting corset tight about the waist. Pressure on the region below the waist line is inevitable and hazardous. It may cause a displacement of the organs in the pelvic region. Tight stocking supporters fastened to the corset in front aggravate the evil. The corset should be adjusted to fit comfortably and support the abdominal region, but be loose at the waist line and above, to allow plenty of room for breathing. It should not be pressed or dragged down by heavy skirts, the weight of which comes on the waist. If a separate skirt is worn rather than a one-piece garment, it should be of light-weight material.

Shoes should be straight on the inside line, should fit the heel and instep snugly, but leave the toes free. Nature meant that we should have free motion of the toes in walking. Pointed toes have a tendency to produce bunions and broken arches. Many who complain of rheumatism in the feet are suffering from arch trouble brought on probably by badly shaped shoes. The sole of the shoe should be as wide as the sole of the foot when one is standing on it. The

heel should be broad, and low enough not to throw the whole weight of the body on the toes, yet if the arch of the foot is unusually high, or on the other hand broken down, a low heel may not be so comfortable and supporting as one of moderate height.

A hat which is heavy and does not afford ventilation to the scalp can do considerable harm to the hair even in a few weeks of wear. The hair loses its resilience and becomes heavy and lifeless. Pressure on the nerves and blood vessels that supply the scalp interferes with their functioning, and combines with the lack of ventilation to bring about the evil results. Girls who are outdoors a great deal in the summer time without hats on soon notice an improvement in the condition of their hair.

The general principles of the hygiene of clothing do not change. Warmth, ventilation, freedom of movement and cleanliness are foundation requirements for every one. How these requirements can best be met in her own case is the part of the individual to decide. As has been seen, the warmth of wool is not suited to all persons and occupations, nor the cooling effect of linen. If students of dress hygiene will interpret its principles intelligently, and use the knowledge as a governing influence in their choice of dress, there will be less of slavish following of the fashions, and more real health and comfort.

QUESTIONS

1. What are some guiding factors in the selection of a dress? Give your interpretation of the meaning of each one.

2. Describe the dress you would consider becoming and appropriate to:

a. A short, stout, middle-aged woman.

b. A tall slim girl of sixteen.

c. A white-haired old lady.

d. A girl with gray eyes and light hair, one with dark eyes and dark hair, and one with brown eyes and auburn hair.

3. For your own satisfaction, begin keeping an account of what your clothes cost. Compare your outlay for the groups of articles given in the text with the suggested apportionment allotted to them.

4. In the paragraph on "durability," in this chapter, comparisons are made between certain fabrics. Make further comparisons by consulting the lists at the end of chapters IV, V, VI, and VII.

5. What points can you make against and in favor of ready-made clothing?

6. In the purchasing of ready-made underwear, how may one help to better labor conditions?

7. What to you seem important points to remember in forming good shopping habits?

8. In connection with hygiene, what main offices should clothing perform for the body?

9. Describe the result of insufficient or unequal clothing on the body's heat supply, and the adjustment the body must make to meet the deficiency.

10. Give the disadvantages of wool in a fabric to be worn next the skin. In what ways may some of these disadvantages be overcome? Under what circumstances would you recommend wool or part wool underwear?

11. Compare cotton, linen and silk for underwear, as to cost, cleanliness and heat conservation.

12. In what respects do the requirements for underwear and outer garments differ in winter? In summer?

13. Which will give more heat protection, two or three light-weight coats, or the same thickness of material in one coat? Why?

14. What rules of hygiene should govern choice of corsets, shoes and hats?

Questions and Problems for Further Study

1. Study the dress of the most becomingly gowned people you meet, and decide in what its becomingness consists. Find in magazines illustrations of garments which are admirable in their design, color, decoration and simplicity.

2. Criticize your own clothing from the hygienic standpoint.

3. Describe the kind of shoe, underwear and outer clothing suitable for a two-year-old child in winter.

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GLOSSARY

Batik. A method of dyeing originating in Java. The pattern is painted on with wax before the material is dyed.

Battening. The pressing together of the filling threads in weaving.

Beetling. A process of finishing cotton and linen goods in which the threads are beaten flat.

Boiled-off silk. Silk from which the sericin or gum has been removed.

Boll. The pod or capsule of the cotton plant which contains the cotton fibers.

Breaking. The crushing and first separation of the woody portion from flax and similar fibers, after the retting process.

Brides. Ties joining the pattern in real lace.

Calendering. A process of giving a smooth, glossy surface to cotton cloth particularly by means of pressure under rollers.

Carbonizing. Removing vegetable matter from wool by acids.

Conditioning. A process of restoring the normal amount of moisture to textile fibers.

Count. The number given to yarn to indicate its fineness.

Crofting. Grass bleaching of linen.

Extract wool. See Remanufactured wool.

Fleece. The wool after shearing from the sheep. Loose wool.

Float. The threads which run from figure to figure in some pattern weaving.

Flocks. Soft short fibers of wool thrown off by certain processes of woolen and worsted manufacture.

Flyer. A U-shaped piece of wood with projecting wires, which revolves around the spindle in the flax wheel. A similar device in a spinning frame which revolves about the bobbin to twist the yarn.

Fulling or milling. Processes of shrinking or felting woolen cloth for the purpose of making a close, firm, material such as broadcloth.

Gassing. Singeing protruding fiber ends in a gas flame.

Ginning. Separating cotton fibers from the seed.

Hackling. Freeing flax fibers from woody particles and tow by a process similar to combing.

Harness. A collection of healds or heddles.

Healds or heddles. Cords or sticks having eyes or loops, through which the warp threads pass in the loom.

Kemps. Coarse, inferior wool fibers which do not dye well.

Lappet weave. Weaving in which designs are embroidered on a fabric.

Leno weave. Gauze weaving in combination with plain weaving.

Line. Long flax fibers.

Lint. Cotton fibers after removal from the seed.

Linters. Short hairs left attached to cotton seeds after the first ginning.

Mangling. A process in the finishing of materials which smooths the cloth and gives luster.

Mercerized cotton. Cotton treated with caustic alkali. The product is stronger and more lustrous than unmercerized cotton.

Mungo. See Remanufactured wool.

Needle point. Real lace made by hand with a needle. The stitch resembles buttonhole stitch.

Neps. Small knots in cotton due to irregular growth or poor ginning.

Noils. Short fibers left in combing worsted yarn.

Organzine. Strong twisted silk thread used for warp.

Pelt. The skin of the sheep before the wool is removed.

Pick glass. A small magnifying glass used to determine the weave and quality of materials.

Picking. Putting in the filling threads in weaving.

Pulled wool. Wool removed from dead pelts by treatment with chemicals.

Reed. An attachment of the lathe or battening stick in a loom, consisting of cords or wires through which the warp threads pass.

Remanufactured wool. Wool recovered from cast-off clothing, etc. Three grades exist: (1) Shoddy. From unfelted clothing such as sweaters, stockings and blankets. (2) Mungo. From felted material such as broadcloth. (3) Extract. From mixed wool and cotton fabrics. The cotton is removed by carbonizing.

Retting. Rotting the flax stalks in order to separate the flax fibers from the woody portion.

Rippling. Removing seeds and leaves from the flax stalk.

Roughing. Coarse combing or hackling of flax.

Roving. The last stage of drawing out a lap or roll of fibers in preparation for spinning.

Schreinerized cotton. Cotton cloth finished to give the appearance of mercerized cotton.

Scutching. Knocking off the woody particles adhering to flax after the breaking process.

Shed. An opening made in the warp threads to allow the filling thread to pass through.

Shoddy. See Remanufactured wool.

Singles. Silk thread having no twist.

Sliver. A slender, untwisted rope of cotton or other fibers ready for drawing out and spinning.

Slubbing. An intermediate stage of drawing out the sliver.

Sorts. Division of a pelt into grades of wool.

Souple. Silk from which about one-sixth of the gum has been removed.

Spun or waste silk. Inferior silk from various sources, which cannot be reeled and is carded and spun.

Staple. The general fibers of wool, cotton, etc., with especial reference to quality, particularly the length of fiber.

Teazling. The napping of broadcloth or other cloths, by which the surface is roughed up by teazles.

Temple or tenterhook. An attachment of the hand loom which kept the weave stretched to even width.

Thrown silk. After reeling, silk is carried through processes analogous to spinning, which result in threads known as thrown silk.

Tops. The long wool fibers prepared for worsted yarn by combing.

Tow. Coarse or broken parts of flax or hemp, separated by hackling from the linen fibers.

Tram. Silk thread used for filling.

Warp or ends. The threads running lengthwise of a weave.

Wattling. An early form of weaving.

Weft, woof, picks or filling. The threads running across the warp in a weave.

Woolens. Materials made from wool fibers which have not been combed and laid parallel.

Worsteds. Materials made from combed and parallel fibered wool yarn.

INDEX

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Printed in the United States of America.

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BY

MARY SCHENCK WOOLMAN, B.S.

President of the Women's Educational and Industrial Union, Boston, acting head of the Department of Household Economics, Simmons College, recently Professor of Domestic Art in Teachers College

AND

ELLEN BEERS McGOWAN, B.S.

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